SOIL SURVEY OF

McLean County, North Dakota

United States Department of Agriculture
Soil Conservation Service
United States Department of the Interior
Bureau of Indian Affairs
in cooperation with
North Dakota Agricultural Experiment Station

This is a publication of the National Cooperative Soil Survey, a joint effort of the United States Department of Agriculture and agencies of the States, usually the Agricultural Experiment Stations. In some surveys, other Federal and local agencies also contribute. The Soil Conservation Service has leadership for the Federal part of the National Cooperative Soil Survey. In line with Department of Agriculture policies, benefits of this program are available to all, regardless of race, color, national origin, sex, religion, marital status, or age.

Major fieldwork for this soil survey was completed in the period 1969–73. Soil names and descriptions were approved in 1974. Unless otherwise indicated, statements in the publication refer to conditions in the county in 1973. This survey was made cooperatively by the Soil Conservation Service, the Bureau of Indian Affairs, United States Department of the Interior, and the North Dakota Agricultural Experiment Station. It is part of the technical assistance furnished to the West McLean Soil Conservation District and the South McLean Soil Conservation District. Financial assistance was provided by McLean County.

HOW TO USE THIS SOIL SURVEY

THIS SOIL SURVEY contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, and other structures; and in judging the suitability of tracts of land for farming, industry, and recreation.

Locating Soils

All the soils of McLean County are shown on the detailed map at the back of this publication. This map consists of many sheets made from aerial photographs. Each sheet is numbered to correspond with a number on the Index to Map Sheets.

On each sheet of the detailed map, soil areas are outlined and are identified by symbols. All areas marked with the same symbol are the same kind of soil. The soil symbol is inside the area if there is enough room; otherwise, it is outside and a pointer shows where the symbol belongs.

Finding and Using Information

The "Index to Mapping Units" on page ii lists all of the soils in the county by map symbol and shows the page where each soil is described. The capability unit and range site to which each soil has been assigned are specified at the end of the soil description.

Individual colored maps showing the relative suitability or degree of limitation of soils for many specific purposes can be developed by using the soil map and information in the text. Translucent material can be used as an overlay over the soil map and colored to show soils that have the same limitation or suitability. For example, soils with a slight limitation for a given use can be colored green, those with a moderate limitation can be colored yellow, and those with a severe limitation can be colored red.

Farmers and those who work with farmers can learn about use and management of the soils from the soil descriptions and from the descriptions of the capability units.

Foresters and others can refer to the section "Woodland and Windbreaks," where the soils of the county are grouped according to their suitability for trees.

Game managers, sportsmen, and others can find information about soils and wildlife in the sections "Wildlife" and "Recreation."

Ranchers and others can find, under "Range," information on range sites, range condition, production, management, and the names of many of the plants that grow on each range site.

Community planners and others can read about soil properties that affect the choice of sites for dwellings, industrial buildings, and recreation areas in the sections "Wildlife," "Recreation," and "Engineering."

Engineers and builders can find, under "Engineering," tables that contain estimates of soil properties and information about soil features that affect engineering practices.

Scientists and others can read about how the soils formed and how they are classified in the section "Formation and Classification of Soils."

Newcomers in McLean County may be especially interested in the section "General Soil Map," where broad patterns of soils are described. They may also be interested in the information about the county given in the section "Environmental Factors Affecting Soil Use."

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Issued ----------June 1979

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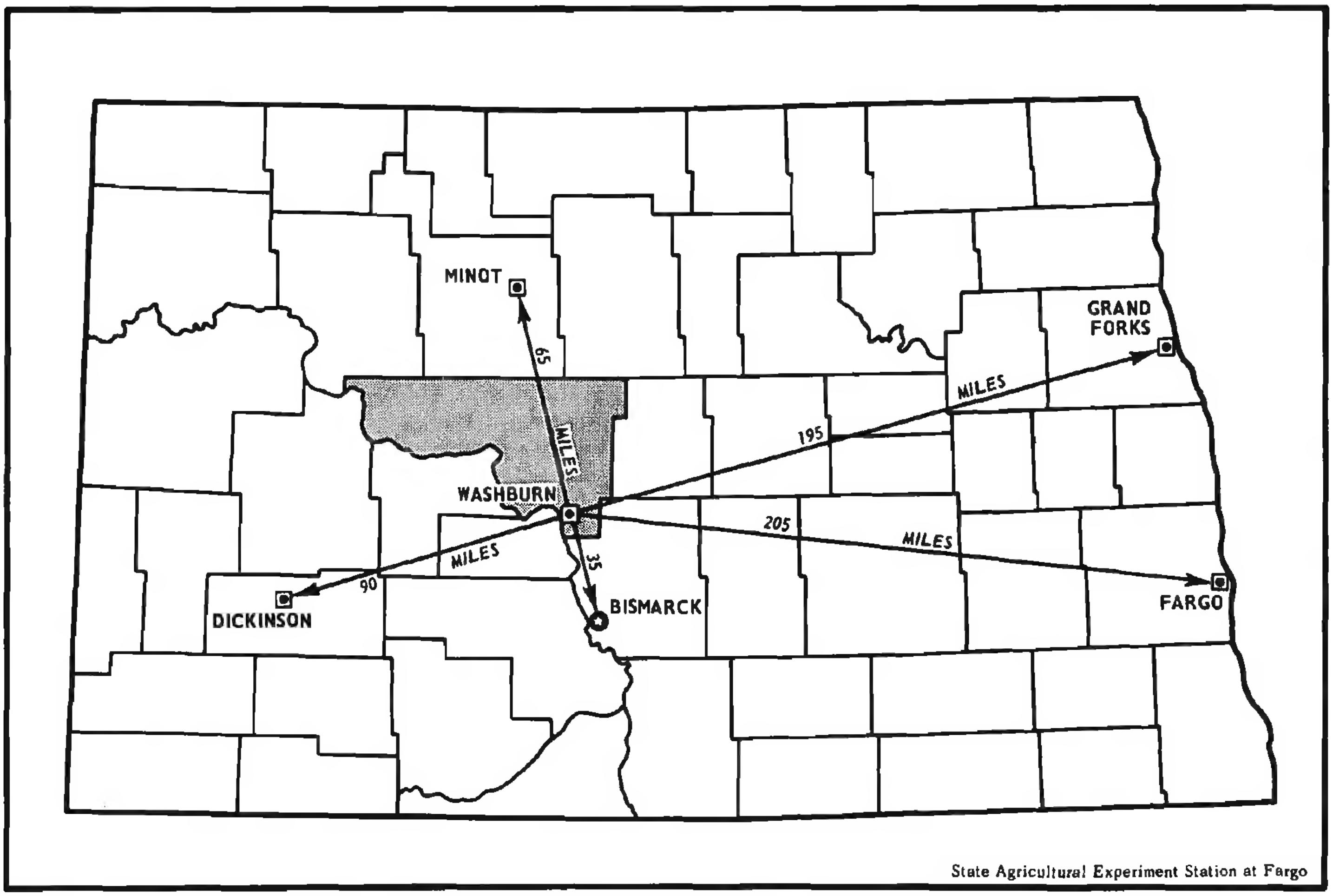

Location of McLean County in North Dakota.

SOIL SURVEY OF McLEAN COUNTY, NORTH DAKOTA

By Lester C. Brockmann, Eldon E. Evenson, James F. Strum, Truman C. Anderson, Jr., William F. Freymiller, Paul K. Weiser, and Robert L. Howey, Soil Conservation Service

United States Department of Agriculture, Soil Conservation Service, United States Department of the Interior, Bureau of Indian Affairs, in cooperation with the North Dakota Agricultural Experiment Station

McLEAN COUNTY is in the central part of North Dakota (see facing page). It has a total land area of 2,065 square miles, or 1,321,600 acres. Washburn, the county seat, is in the south-central part of the county.

This county has a dry-subhumid, continental climate that is characterized by cold winters and warm summers. Its physiography consists of glacial landforms, loess deposits, windblown sands, glaciofluvial deposits, a narrow area of steep residual plains, and recent alluvium bottom land. The Missouri River, which forms the southwestern boundary of the county, drains most of the county. Garrison Dam, on the Missouri River near Riverdale, forms Lake Sakakawea. Major tributaries are Painted Woods Creek, Turtle Creek, Buffalo Creek, Coal Lake Coulee, Snake Creek, Douglas Creek, and Deep Water Creek. Much of the runoff collects in depressions and does not reach the creeks and rivers.

About 95 percent of the acreage is in farms, and about 73 percent is cultivated. Spring wheat and Durum wheat are the main crops. Barley, oats, flax, alfalfa, and corn for silage are also extensively grown. Irrigated acreages are planted mostly to hay and silage. There are a few dairy herds in the county, but most of the livestock is beef cattle.

How This Survey Was Made

Soil scientists made this survey to learn what kinds of soil are in McLean County, where they are located, and how they can be used. The soil scientists went into the county knowing they were likely to find many soils they had already seen and perhaps some they had not. They observed the steepness, length, and shape of slopes, the size and nature of streams, the kinds of native plants or crops, the kinds of rock, and many facts about the soils. They dug many holes to expose soil profiles. A profile is the sequence of natural layers, or horizons, in a soil; it extends from the surface down into the parent material that has not been changed much by leaching or by the action of plant roots.

The soil scientists made comparisons among the profiles they studied, and they compared these profiles with those in counties nearby and in places more distant. They classified and named the soils according to nationwide, uniform procedures. The *soil series* and the *soil phase* are the categories of soil classification most used in a local survey.

Soils that have profiles almost alike make up a soil series. Except for different texture in the surface layer, all the soils of one series have major horizons that are similar in thickness, arrangement, and other important characteristics. Each soil series is named for a town or other geographic feature near the place where a soil of that series was first observed and mapped. Arnegard and Parshall, for example, are the names of two soil series. All the soils in the United States having the same series name are essentially alike in those characteristics that affect their behavior in the undisturbed landscape.

Soils of one series can differ in texture of the surface layer and in slope, stoniness, or some other characteristic that affects use of the soils by man. On the basis of such differences, a series is divided into phases. The name of a soil phase indicates a feature that affects management. For example, Lohler silty clay loam is one of several phases within the Lohler series.

After a guide for classifying and naming the soils had been worked out, the soil scientists drew the boundaries of the individual soils on aerial photographs. These photographs show buildings, field borders, trees, and other details that help in drawing boundaries accurately. The soil map at the back of this publication was prepared from aerial photographs.

The areas shown on a soil map are called mapping units. On most maps detailed enough to be useful in planning the management of farms and fields, a mapping unit is nearly equivalent to a soil phase. It is not exactly equivalent, because it is not practical to show on such a map all the small, scattered bits of soil that have been seen within an area that is dominantly of a recognized soil phase.

Some mapping units are made up of soils of different series, or of different phases within one series. Two such kinds of mapping units are shown on the soil map of McLean County: soil complexes and undifferentiated groups.

A soil complex consists of two or more soils, so intricately mixed or so small in size that they cannot be shown separately on the soil map. Each area of a complex contains some of each of the two or more dominant soils. The pattern and relative proportions are about the same in all areas. Generally, the name of a soil complex consists of the names of the dominant

soils, joined by a hyphen. Cohagen-Vebar complex, 15 to 35 percent slopes, is an example.

An undifferentiated group is made up of two or more soils that could be delineated individually but are shown as one unit because, for the purpose of the soil survey, there is little value in separating them. The pattern and proportion of soils are not uniform. An area shown on the map may be made up of only one of the dominant soils, or of two or more. If there are two or more dominant series represented in the group, the name of the group ordinarily consists of the names of the dominant soils joined by "and." Falkirk and Max loams, 1 to 3 percent slopes, is an undifferentiated group in McLean County.

In most areas surveyed there are places where the soil material is so rocky, so shallow, so severely eroded, or so variable that it has not been classified by soil series. These places are shown on the soil map and are described in the survey, but they are called miscellaneous areas and are given descriptive names. Riverwash is an example in this survey.

While a soil survey is in progress, soil scientists take soil samples needed for laboratory measurements and for engineering tests. Laboratory data from the same kinds of soil in other places are also assembled. Data on yields of crops under defined practices are assembled from farm records and from field or plot experiments on the same kinds of soil. Yields under defined management are estimated for all the soils.

Soil scientists observe how soils behave when used as a growing medium for native and cultivated plants, and as material, foundations, or covering for structures. They relate this behavior to properties of the soils. For example, they observe that filter fields for onsite disposal of sewage fail on a given kind of soil, and they relate this failure to slow permeability or a high water table. They see that streets, road pavements, and foundations for houses crack on a given kind of soil, and they relate this failure to the high shrink-swell potential of the soil. Thus, they use observation and knowledge of soil properties, with available research data, to predict limitations or suitability of soils for present and potential uses.

The soil scientists set up trial groups of soils after data has been collected and tested for the main soils in a survey area. They test these groups by further study and by consultation with farmers, agronomists, engineers, and others. Then they adjust the groups according to the results of their study and consultation. Thus, the groups that are finally evolved reflect up-to-date knowledge of the soils and their behavior under current methods of use and management.

General Soil Map

The general soil map at the back of this survey shows, in color, the soil associations in McLean County. A soil association is a landscape that has a distinctive pattern of soils in defined proportions. Typically, it consists of one or more major soils and at least one minor soil, and it is named for the major soils. The soils in one association can occur in another, but in a different pattern.

A map showing soil associations is useful to people who want to have a general idea of the soils in a survey area, who want to compare different parts of that area, or who want to locate large tracts that are suitable for a certain kind of land use. Such a map is useful as a general guide for broad planning on a watershed, a wooded tract, or a wildlife area, or for broad planning of recreational facilities, community developments, and such engineering works as transportation corridors. It is not suitable for detailed planning for farm or field management or for selecting the exact location of a road, building, or other structure, because the soils within an association ordinarily vary in slope, depth, stoniness, drainage, and other characteristics that affect their management.

The terms for texture used in the title of the associations apply to the surface layer. For example in the title, Williams association, the words "medium textured and moderately fine textured" refer to the texture of the surface layer.

The soil associations in this survey area have been grouped into general kinds of landscapes for broad interpretative purposes. Each of the broad groups and the soil associations in it are described on the following pages.

Soils of Glacial Till Areas

The five soil associations of this group occur in most parts of the county. Some soils are on ground moraines, others are on the dead ice moraine in the northeastern one-third of the county, and still others are on valleysides where streams have cut into the till plain. The soils of the ground moraines are nearly level to rolling, those of the dead ice moraine are undulating to steep, and those on valleysides are moderately steep to steep. Soils along valleysides of the Missouri River are moderately deep and shallow over shale bedrock of Tertiary age. All formed in calcareous loam or clay loam glacial till and in alluvium derived from the till.

1. Williams-Bowbells association

Deep, nearly level to gently rolling, well drained and moderately well drained, medium textured and moderately fine textured soils on glacial till plains

This soil association consists of deep soils that formed in glacial till. The landscape is one of smooth swells and swales that have differences in elevation ranging from 3 to 20 feet. It is mostly nearly level and gently sloping. A few steeper slopes occur along ridges and drainageways and around depressions. Slopes are generally short.

This association makes up about 33 percent of the county. It is about 50 percent Williams soils (fig. 1), 30 percent Bowbells soils, and 20 percent minor soils.

The well drained Williams soils are on plane and slightly convex slopes. The surface layer is dark grayish brown loam or clay loam about 5 inches thick. The subsoil is grayish brown to brown clay loam. It is underlain by light brownish gray and light olive brown clay loam that contains a large amount of lime in the upper part.

The moderately well drained Bowbells soils occupy the lower slopes and slightly concave positions in the landscape. The surface layer is dark grayish brown

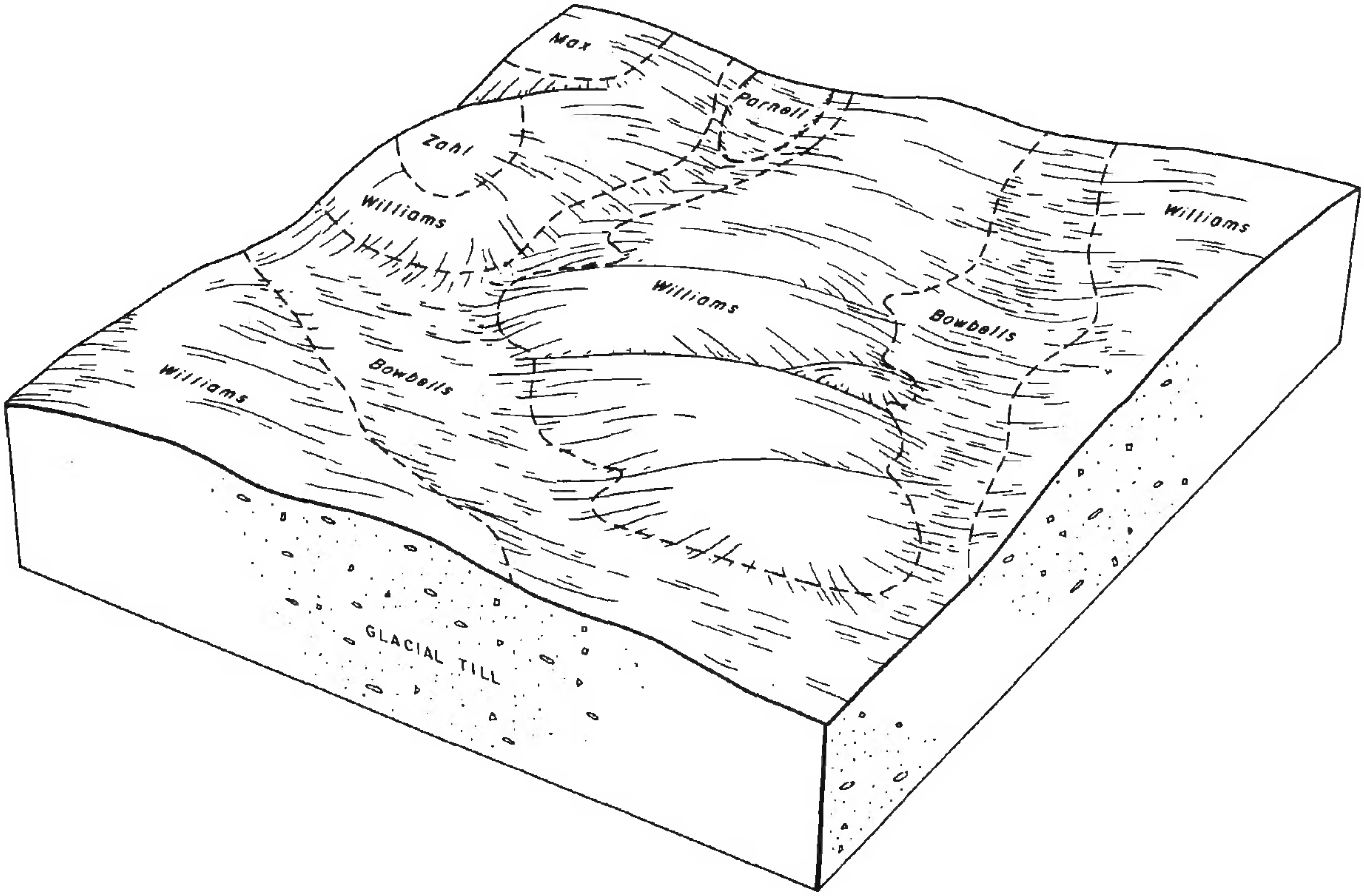

Figure 1.—**Typical pattern of soils and parent material in association 1.**

loam about 9 inches thick. The subsoil is dark grayish brown and grayish brown loam and clay loam about 16 inches thick. It is underlain by light brownish gray and light yellowish brown clay loam.

Minor in this association are the Falkirk, Arnegard, Max, Zahl, Tonka, and Parnell soils. Falkirk soils occupy broad smooth slopes. Arnegard soils are in some of the larger swales. Max soils are on plane and slightly convex slopes. Zahl soils are on the ridges and steeper convex slopes. Tonka and Parnell soils are in the depressions and basins.

This association is well suited to field crops, hay crops, and pasture grasses commonly grown in the county. Fertility and available water capacity are high. The organic-matter content is moderate to high. The main concerns of management are controlling water erosion, improving drainage, and maintaining tilth and fertility.

About 80 percent of this association is used for cultivated crops. Most farms specialize in cash grain crops. Some are grain and livestock enterprises.

2. *Williams association*

Deep, nearly level to gently rolling, well drained, medium textured and moderately fine textured soils on glacial till uplands

This soil association consists of deep soils that formed in glacial till. The landscape is a ground moraine and a dead ice moraine. Local relief ranges from 10 to 30 feet. Slopes are short and irregular. Most slopes are undulating to gently rolling, some are nearly level, and a few areas have steep slopes. Depressions and stones are common in many areas.

This association makes up about 31 percent of the county. It is about 45 percent Williams soil, about 40 percent of approximately equal parts of Max, Bowbells, and Zahl soils, and 15 percent Parnell and Tonka soils.

The well drained Williams soils are on smooth plane slopes. The surface layer is dark grayish brown loam or clay loam about 5 inches thick. The subsoil is grayish brown to brown clay loam. It is underlain by light brownish gray and light olive brown clay loam that contains a large amount of lime in the upper part.

Max soils have a thinner surface layer and subsoil than Williams soils and are on plane and slightly convex slopes above those soils.

Bowbells soils have a thick surface layer and are on foot slopes and in swales. Zahl soils have a thin surface layer and are on convex ridges and steep slopes.

The wet Parnell and Tonka soils are in the depressions and basins.

Most of this association is suited to the field crops, hay crops, and pasture grasses commonly grown in the county. Fertility is high, and the organic-matter content is moderate. Available water capacity is high. The main management concern is controlling water erosion. Numerous depressions and stones create farming problems.

About 60 percent of this association is used for cultivated crops. Most farms are combination grain and livestock enterprises.

3. *Max-Zahl-Williams association*

Deep, nearly level to steep, well drained, medium textured and moderately fine textured soils on glacial till uplands

This soil association consists of deep soils that formed in glacial till. The landscape is mostly a dead ice moraine and areas of end moraines and ground moraines. Local relief ranges from 15 to 50 feet. Slopes are short and irregular. Most slopes are rolling. Some areas are hilly and steep. Depressions, stones, and boulders are common.

This association makes up about 10 percent of the county. It is about 40 percent Max soils (fig. 2), 20 percent Zahl soils, 20 percent Williams soils, and 20 percent minor soils.

The well drained Max soils occupy most plane and slightly convex slopes in the landscape. The surface layer is dark grayish brown loam about 5 inches thick. The subsoil is dark grayish brown loam. It is underlain by light brownish gray and light olive brown calcareous clay loam and loam.

The well drained Zahl soils are on ridges and steep slopes. The surface layer is dark grayish brown loam about 6 inches thick. It is underlain by light brownish gray and light olive gray calcareous loam and clay loam.

Williams soils occupy the smoother, less sloping parts of the landscape. The surface layer is dark grayish brown loam or clay loam about 5 inches thick. The subsoil is grayish brown to brown clay loam. It is underlain by light brownish gray and light olive brown clay loam that contains a large amount of lime in the upper part.

Minor in this association are Bowbells, Arnegard, Parnell, and Tonka soils.

Bowbells and Arnegard soils are on foot slopes and in swales. Parnell and Tonka soils occupy depressions and basins.

The more gently sloping soils in this association are

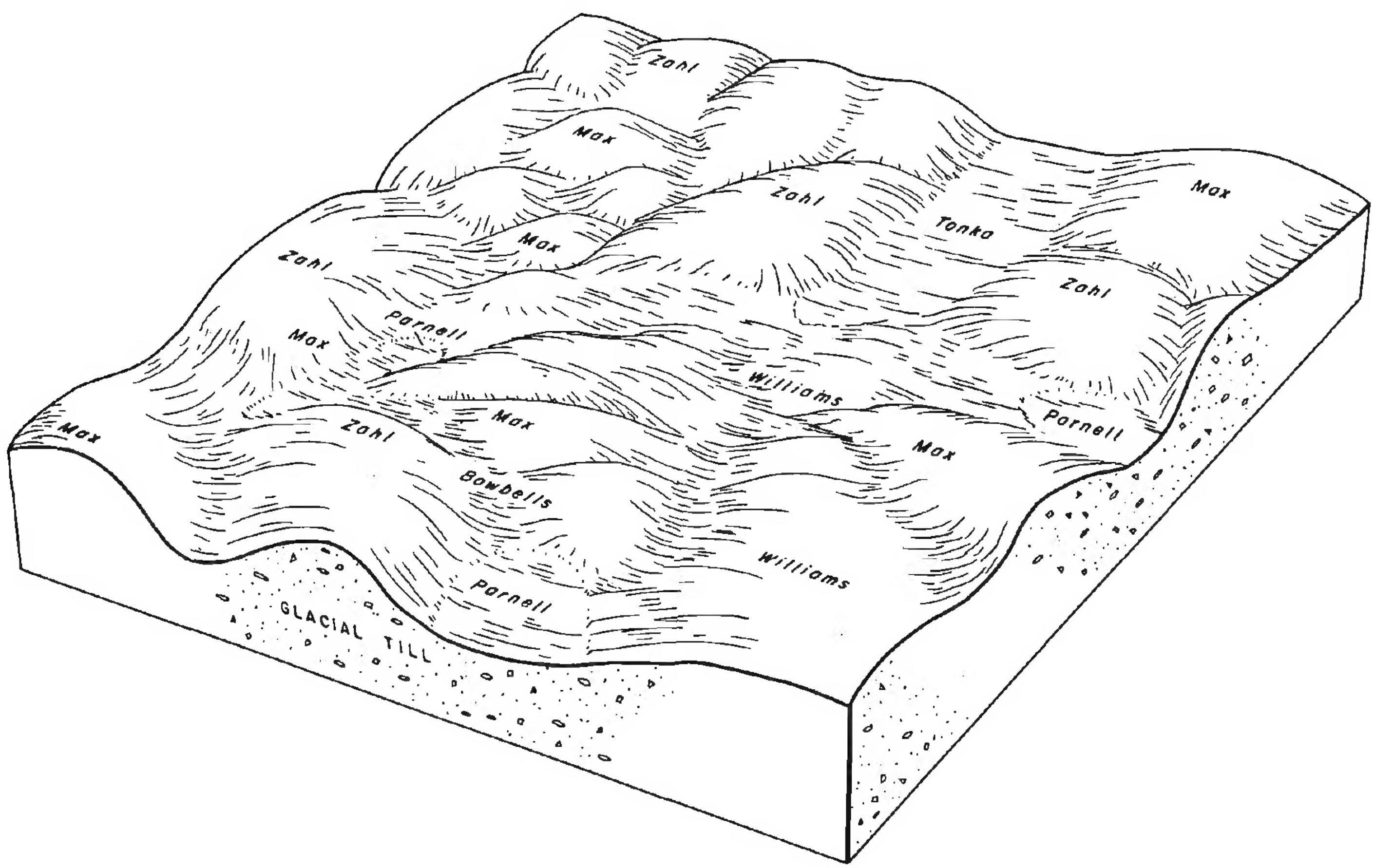

Figure 2.—**Typical pattern of soils and parent material in association 3.**

suited to the field crops, hay crops, and pasture grasses commonly grown in the county. Fertility is low to high, and the organic-matter content is moderate. Available water capacity is high. The main concern of management is controlling water erosion and soil blowing and protecting the native plant cover from overuse. The topography, numerous depressions, and stones create farming problems.

About 75 percent of this association is in native grass, and raising livestock is the main enterprise. Most cultivated areas are gently sloping.

4. *Zahl-Max association*

Deep, hilly and steep, well drained, medium textured soils on glacial till uplands

This soil association consists of deep soils that formed in glacial till. The landscape is hilly and steep. Local relief ranges from 20 to 100 feet. Slopes are short and irregular. Depressions, stones, and boulders are common.

This association makes up about 3 percent of the county. It is about 40 percent Zahl soils, 35 percent Max soils, and 25 percent Parnell, Bowbells, Williams, and Arnegard soils.

The well drained Zahl soils are on ridges and steep slopes. The surface layer is dark grayish brown loam about 6 inches thick. It is underlain by light brownish gray and light olive gray calcareous loam and clay loam.

The well drained Max soils occupy mid and lower slopes in the landscape. The surface layer is dark grayish brown loam about 5 inches thick. The subsoil is dark grayish brown clay loam. It is underlain by light brownish gray and light olive brown calcareous clay loam and loam.

Parnell soils are in closed depressions. Bowbells and Arnegard soils are on foot slopes and in swales. Williams soils are on the few gentle plane slopes.

Pasture grasses grow moderately well on these soils. Fertility is low to moderate, and organic-matter content is moderate. Available water capacity is high. The main concern of management is protecting the native plant cover from grazing damage.

Because this association is steep, nearly all of it is used for grazing. Forage plants grow moderately well. Raising livestock is the main enterprise.

5. *Zahl-Cabba association*

Deep to shallow, moderately steep and steep, well drained, medium textured soils on glaciated soft shale uplands

This soil association consists of deep soils that formed in glacial till and shallow soils that formed in soft shale. The landscape is moderately steep to steep. Local relief ranges from 20 to more than 100 feet. This association commonly parallels deeply entrenched drainageways. It is mantled with glacial till, but subsequent erosion and downcutting have exposed both till and soft shale on the same slope.

This association makes up about 5 percent of the county. It is about 40 percent Zahl soils, 30 percent Cabba soils, and 30 percent minor soils.

The well drained Zahl soils are on the upper slopes and convex ridges. They have a surface layer of dark grayish brown loam about 6 inches thick. This layer is underlain by light grayish brown and light olive gray calcareous loam and clay loam.

The shallow Cabba soils at the lower elevations in the landscape are well drained. They have a surface layer of grayish brown loam about 3 inches thick. This layer is underlain by light gray loam that grades into soft shale at a depth of about 17 inches.

Minor in this association are Cohagen, Flasher, Morton, Vebar, Regent, Arnegard, Williams, and Max soils.

Cohagen and Flasher soils are in the steep parts of the association. Arnegard soils are in swales. Morton, Vebar, and Regent soils are at the lower elevations in the landscape, and Williams and Max soils are at the higher elevations. Slopes are smooth.

Pasture grasses grow moderately well on the soils of this association. Fertility is low, and organic-matter content is moderate or low. Available water capacity is low to high. The main concern of management is protecting the native plant cover from grazing damage and subsequent erosion.

Because of steep slopes, nearly all of this association is used for grazing. Forage plants grow moderately well. Raising livestock is the main enterprise.

Soil of Loess Mantled Areas

The two soil associations in this group are on uplands and terraces east of the Missouri River Valley. Areas are ½ mile to 10 miles wide. The soils formed in wind deposited silty sediment.

6. *Mandan association*

Deep, nearly level to rolling, well drained, medium textured soils on terraces

This association consists of deep, nearly level to sloping soils on terraces and benches adjacent to the valley of the Missouri River. Nearly level and gently sloping landscapes are most common. Slopes are dominantly long and smooth. A few short steep slopes occur along drainageways.

The well drained, nearly level to sloping Mandan soils are in smooth areas. They have a surface layer of dark grayish brown silt loam about 10 inches thick. The subsoil is grayish brown silt loam. It is underlain by light brownish gray, calcareous silt loam.

Linton soils, which also are well drained, are in the steeper convex areas. Temvik and Wilton soils are on side slopes at slightly higher positions in the landscape. Grassna soils are in smooth concave swales. Grail soils, which are more clayey throughout, are on smooth terraces and in concave areas.

The soils in this association are well suited to field crops, hay crops, and pasture grasses commonly grown in the county. Fertility is high, and organic-matter content moderate. Available water capacity is high. The main concern of management is controlling soil blowing.

Most of the association is used for small grain and combination small grain and livestock enterprises. About 80 percent is used for cultivated crops. Some areas are irrigated.

7. *Wilton-Williams-Mandan association*

Deep, nearly level to rolling, well drained, medium textured and moderately fine textured soils on terraces and uplands

This soil association consists of deep soils on nearly level to rolling landscapes where differences in elevation range from about 10 to 50 feet. There are a few undrained depressions. The soils formed in materials deposited by wind and in glacial till.

This soil association makes up about 5 percent of the county. It is about 40 percent Wilton soils (fig. 3), 20 percent Williams soils, 15 percent Mandan soils, and 25 percent Temvik, Linton, Grassna, Bowbells, Parnell, and Zahl soils.

The well drained Wilton soils are nearly level to gently sloping. They have a surface layer of dark grayish brown silt loam about 8 inches thick. The subsoil is dark grayish brown and grayish brown silt loam. It is underlain by light brownish gray calcareous clay loam.

The well drained Williams soils are gently undulating to gently rolling. They have a surface layer of dark grayish brown loam or clay loam about 5 inches thick. The subsoil is grayish brown to brown clay loam. It is underlain by light brownish gray and light olive brown clay loam that contains a large amount of lime in the upper part.

The nearly level to sloping Mandan soils are in smooth areas adjacent to the steep breaks of the Missouri River. They have a surface layer of dark grayish brown silt loam about 10 inches thick. The subsoil is grayish brown silt loam. It is underlain by light brownish gray, calcareous silt loam.

Temvik soils, which are well drained, are in slightly convex areas in close association with Wilton soils. The more sloping Linton soils are in convex areas associated with Mandan soils. Grassna and Bowbells soils are in swales and concave areas. Parnell soils are mostly in undrained depressions. Zahl soils, which are well drained, are on ridges and crests of hills.

The soils in this association are suited to the field crops, hay crops, and pasture grasses commonly grown in the county. Fertility is medium or high, and organic-matter content is moderate. Available water capacity is high. The main farming hazards are soil blowing and water erosion.

About 80 percent of this association is used for cultivated crops. Some farms specialize in cash grain crops. Some are combination small grain and livestock enterprises.

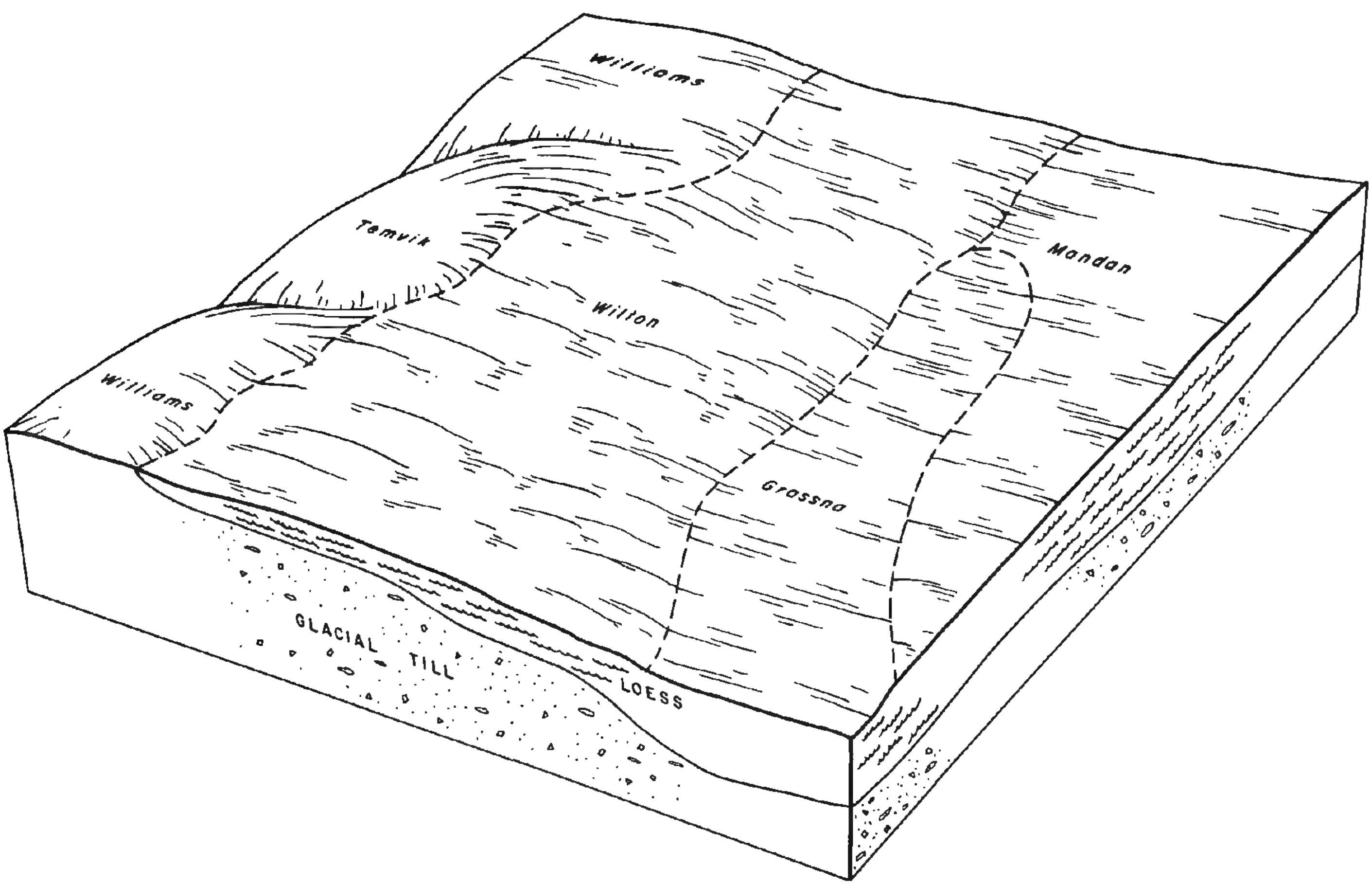

Figure 3.—Typical pattern of soils and parent material in association 7.

Soils of Glacio-Lacustrine Areas

The one soil association in this group occupies areas of glacial lake sediment. Areas are mostly nearly level, but some are sloping. The soils formed in very fine sandy loam, loam, silt loam, and silty clay loam textured material.

8. *Roseglen-Makoti association*

Deep, nearly level to moderately sloping, moderately well drained, medium textured and moderately fine textured soils on lake plains

This soil association consists of deep soils on glacial lake plains. Slopes are typically short. Changes in elevation are less than 20 feet.

This association makes up about 2 percent of the county. It is about 45 percent Roseglen soils (fig. 4), about 40 percent Makoti soils, and 15 percent Tansem, Parshall, Lihen, Sinai, and Nutley soils. Max and Williams soils are on nearby glacial till plains.

Roseglen soils have a surface layer of dark grayish brown silt about 6 inches thick. The subsoil is grayish brown and light olive brown silt loam and loam. It is underlain by light olive brown and light yellowish brown loam.

Makoti soils have a surface layer of dark gray silty clay loam about 6 inches thick. The subsoil is dark grayish brown and grayish brown silty clay and silty clay loam. It is underlain by light brownish gray and olive yellow stratified silty clay loam. Makoti soils are lower in the landscape than Roseglen soils.

Tansem soils are on convex slopes associated with Roseglen soils. The moderately coarse and coarse textured Parshall and Lihen soils are on slightly higher convex slopes. Nutley and Sinai soils are on fine textured parts of the glacial lake plains.

These soils are well suited to field crops, hay crops, and pasture grasses commonly grown in the county. Fertility and the organic-matter content are high. Available water capacity is high. The main hazard is soil blowing.

Nearly all of this association is used for cultivated crops. Most of the area is used for cash crops and combination cash crop and livestock enterprises.

Soils of Glacial Outwash Areas

The two soil associations in this group occupy a large area in the eastern part of the county and smaller areas scattered throughout the county. The soils

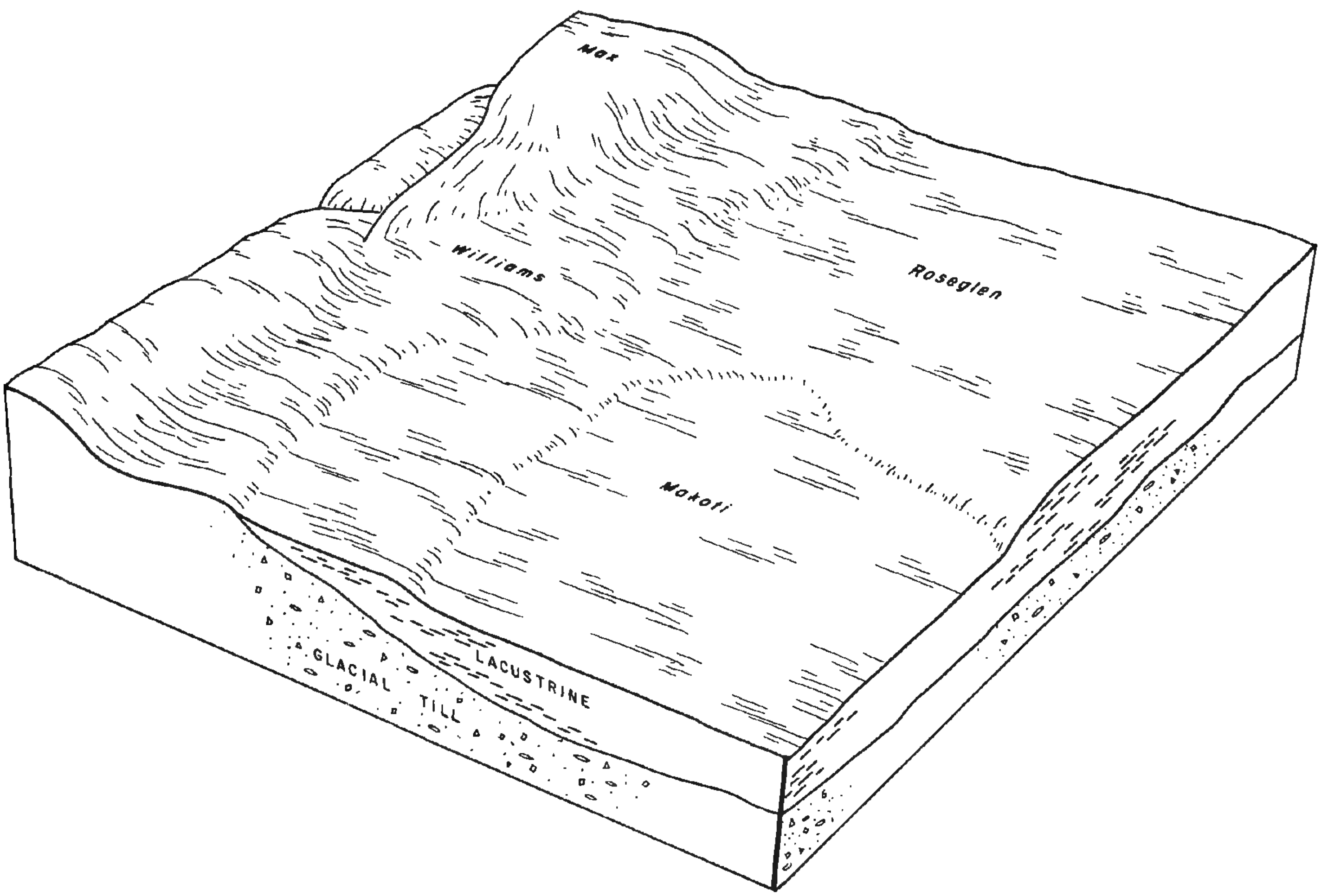

***Figure 4.*—Typical pattern of soils and parent material in association 8.**

formed in sandy, gravelly, and loamy material that was carried by glacial melt water and deposited on terraces and plains and in channels.

9. *Parshall-Lihen-Flaxton association*

Deep, nearly level to rolling, well drained, medium to coarse textured soils on outwash plains and sand mantled uplands

This soil association consists of deep soils that formed in moderately coarse and coarse textured glacial outwash material. Slopes are dominantly nearly level to rolling. A few areas of hummocky, wind reworked materials are steeper.

This association makes up about 1 percent of the county. It is about 45 percent Parshall soils (fig. 5), about 20 percent Lihen soils, about 15 percent Flaxton soils, and 20 percent Krem, Seroco, Telfer, and Ruso soils.

Williams soils are on nearby glacial till plains.

Parshall and Lihen soils are intermingled in some lower lying, undulating areas. Parshall soils have a surface layer of dark grayish brown fine sandy loam or loam about 5 inches thick. The subsoil is dark grayish brown and grayish brown fine sandy loam. It is underlain by grayish brown and light brownish gray calcareous sandy loam and loamy sand. Lihen soils have a surface layer of dark grayish brown loamy fine sand about 22 inches thick. This layer is underlain by grayish brown and light brownish gray loamy sand and loamy fine sand.

Flaxton and Krem soils are in higher lying convex positions. In the Flaxton soils the upper 31 inches is dark grayish brown or grayish brown fine sandy loam. It is underlain by clay loam glacial till. In the Krem soils the upper 28 inches is dark grayish brown loamy fine sand. It is underlain by clay loam glacial till.

Seroco and Telfer soils are coarse textured. They are in rolling to steep, hummocky, convex areas. Ruso soils have a moderately coarse textured surface layer and are underlain by sand and gravel.

Most of the association is suited to the field crops, hay crops, and pasture grasses commonly grown in the county. Fertility is medium, and the organic-matter content is moderate to high. Available water capacity is moderate to high. The main concerns of management are controlling soil blowing and maintaining tilth and fertility.

About 75 percent of this association is used for cultivated crops. Most of the area is used for small grain and combination small grain and livestock enterprises.

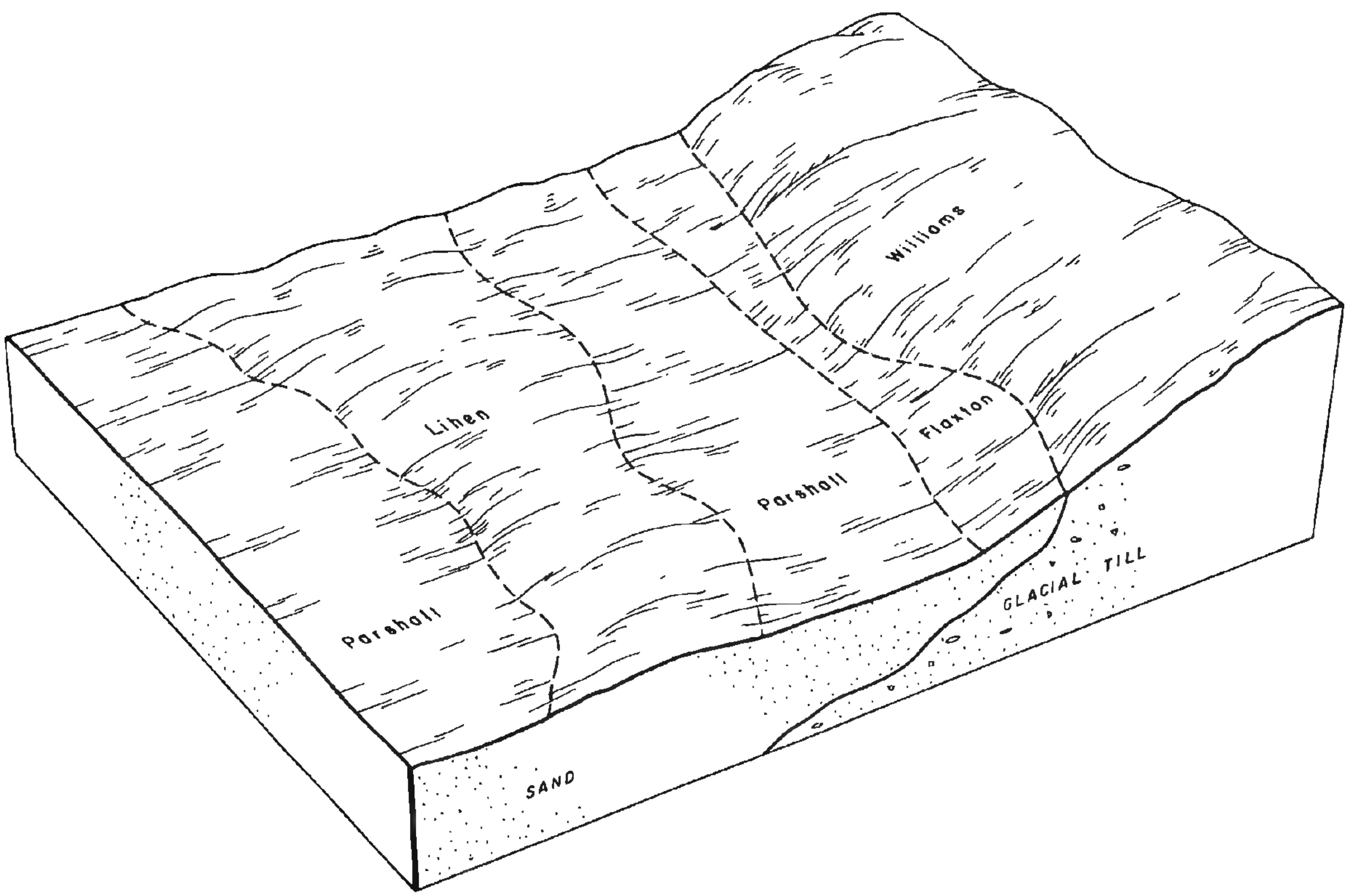

Figure 5.—Typical pattern of soils and parent material in association 9.

10. Ruso-Bowdle-Wabek association

Nearly level to rolling, well drained and excessively drained, moderately coarse to medium textured soils that are moderately deep to very shallow over sands and gravel on outwash plains and terraces

This association consists mostly of nearly level and undulating soils in glacial outwash areas. There are numerous ridges and knobs and some areas of low, poorly drained soils and marshes.

This association makes up about 8 percent of the county. It is about 50 percent Ruso soils (fig. 6), 20 percent Bowdle soils, 10 percent Wabek soils, and 20 percent Manning, Stady, Marysland, Colvin, and Max soils. Zahl soils are on nearby glacial till plains.

The well drained and less sloping Ruso soils are in smooth areas. They have a surface layer of dark grayish brown coarse sandy loam about 14 inches thick. The subsoil is grayish brown coarse sandy loam. It is underlain by grayish brown, light brownish gray, olive gray, and yellowish brown sand and gravel.

The nearly level and gently sloping Bowdle soils are in smooth areas and are somewhat excessively drained. They have a surface layer of dark grayish brown loam about 13 inches thick. The subsoil is dark grayish brown and grayish brown loam. It is underlain by light brownish gray sand and gravel.

Ruso and Bowdle soils are generally not intricately associated. Wabek soils, however, are closely associated with both Ruso and Bowdle soils.

The excessively drained Wabek soils are on the steeper, convex part of the landscape. They have a surface layer of dark grayish brown loam, gravelly loam, or coarse sandy loam about 7 inches thick. It is underlain by light brownish gray sand and gravel.

The gently sloping and sloping Manning and Stady soils are on the convex parts of the landscape.

Marysland and Colvin soils are wet and calcareous and are in swales and in low areas. The well drained Max soils are gently sloping to rolling and are underlain by loamy glacial till.

Nearly all of this association is suited to the field crops, hay crops, and pasture grasses commonly grown in the county. Fertility is low to medium, and organic-matter content is moderate or high. Available water capacity is very low to moderate. The main concern of management is controlling soil blowing and the very low to moderate available water capacity.

About 75 percent of this association is used for cultivated crops. Some areas are irrigated. Livestock is the major enterprise on the shallower soils. These soils are a source of gravel and sand.

Soils of Bottom Land

The soil association in this group is on low terraces

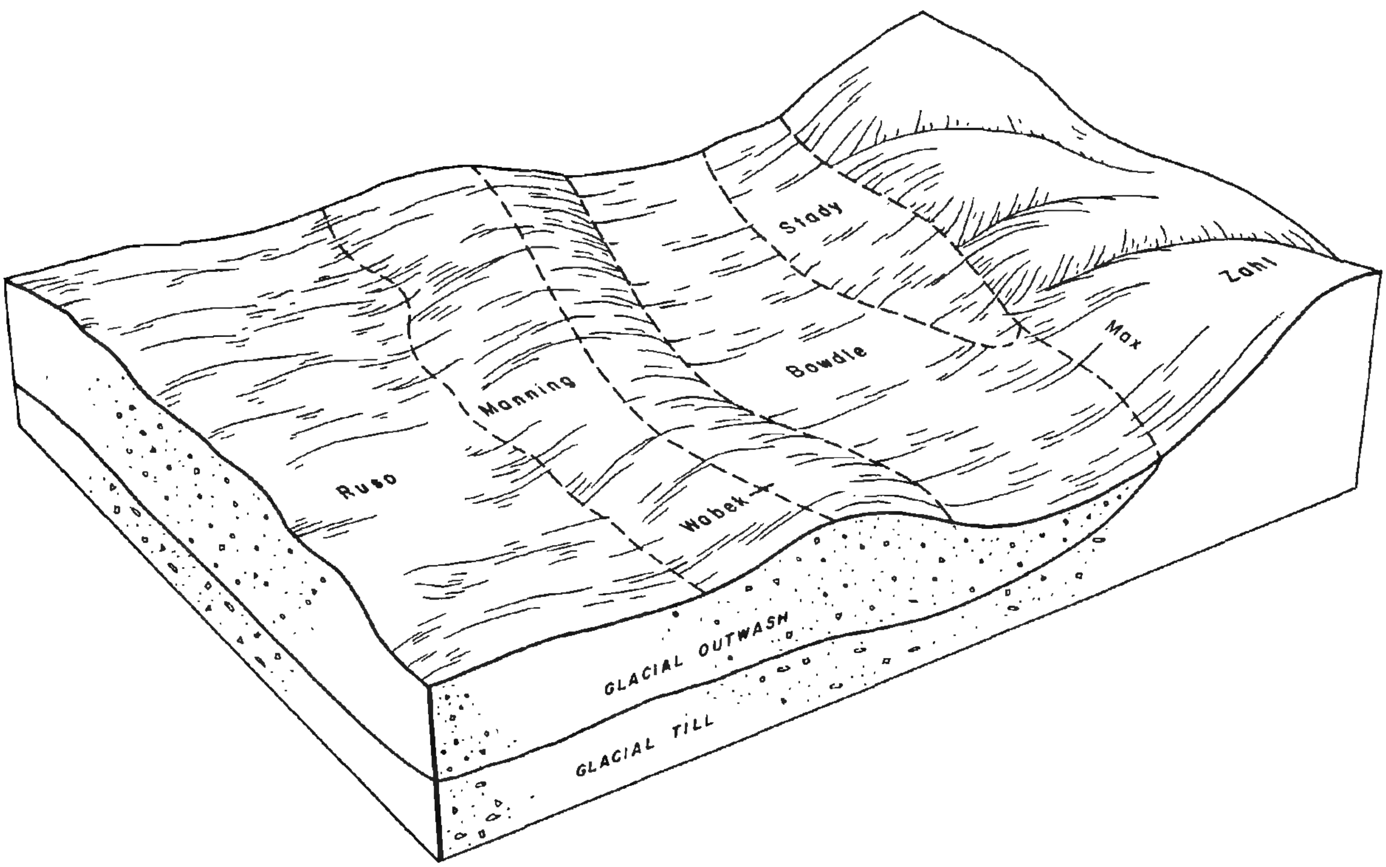

Figure 6.—Typical pattern of soils and parent material in association 10.

and flood plains along the Missouri River. The soils are nearly level and formed in stratified, recently deposited alluvium that ranges from fine sand to clay in texture.

11. Havrelon-Banks-Lohler association

Deep, nearly level, moderately well drained to somewhat excessively drained, fine to medium textured and coarse textured soils on bottom land

This association consists of soils on bottom land of the Missouri River. Slopes are dominantly nearly level. A few short slopes occur on bench edges and along drainage channels.

This association makes up about 1 percent of the county. It is about 65 percent Havrelon soils (fig. 7), 15 percent Banks soils, 8 percent Lohler soils, and 12 percent Trembles and Lallie soils and Riverwash. Cabba and Zahl soils are on nearby uplands.

The well drained Havrelon soils, which are medium textured and calcareous, are in slightly higher lying areas. The surface layer is light brownish gray very fine sandy loam, loam, or silty clay loam about 6 inches thick. It is underlain by light brownish gray and grayish brown loam, very fine sandy loam, silty clay, and silty clay loam.

Banks soils, which are coarse textured and somewhat excessively drained, are on the higher lying parts of each terrace. The surface layer is grayish brown loamy fine sand and loam. It is underlain by light brownish gray fine sand, loam, and loamy fine sand.

Lohler soils, which are fine textured or moderately fine textured, moderately well drained and calcareous, are in the lower lying level areas. The surface layer is grayish brown silty clay loam or silty clay about 4 inches thick. It is underlain by light brownish gray, grayish brown, and light yellowish brown silty clay loam, silty clay, and very fine sandy loam.

Lallie soils are fine textured and poorly drained. Trembles soils are moderately coarse textured and well drained. Riverwash, a miscellaneous area near the river, is nearly barren, is subject to flooding, and has a water table close to the surface.

Small grain, corn, and alfalfa grow well in most areas. Fertility and organic-matter content are low to medium, and available water capacity is low to high. The main concerns of management are improving drainage and maintaining tilth and fertility.

Approximately 70 percent of this association is cultivated. Small grain is the main crop. Alfalfa, corn, sugar beets, and tame grasses are also grown. Some

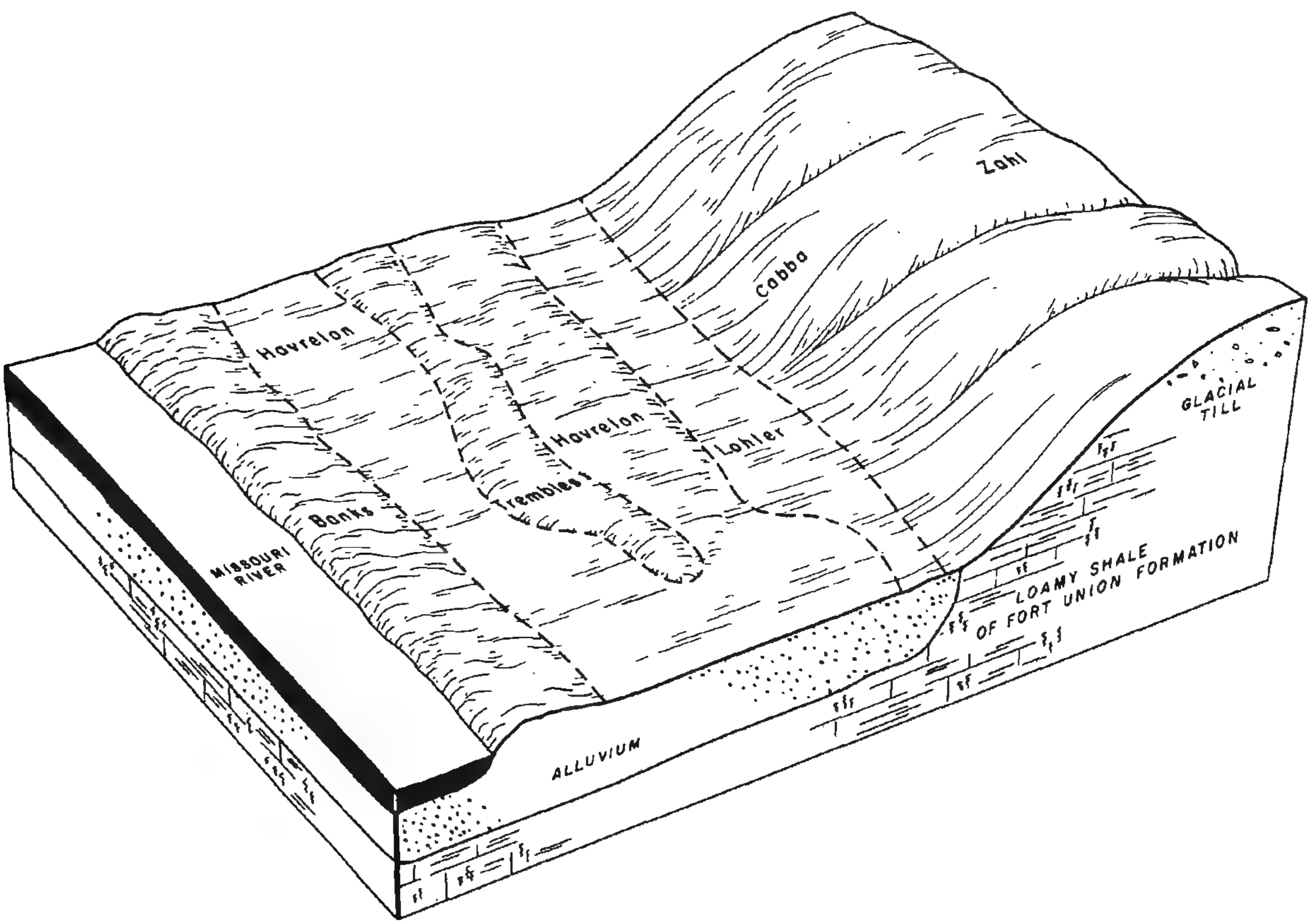

Figure 7.—**Typical pattern of soils and parent material in association 11.**

areas are irrigated. Much of the uncultivated land is in trees, brush, and grass and is used for grazing. Some wooded areas are used for wildlife.

Descriptions of the Soils

This section describes the soil series and mapping units in McLean County. Each soil series is described in detail, and then, briefly, each mapping unit in that series. Unless it is specifically mentioned otherwise, it is to be assumed that what is stated about the soil series holds true for the mapping units in that series. Thus, to get full information about any one mapping unit, it is necessary to read both the description of the mapping unit and the description of the soil series to which it belongs.

An important part of the description of each soil series is the soil profile, that is, the sequence of layers from the surface downward to rock or other underlying material. Each series contains two descriptions of this profile. The first is brief and in terms familiar to the layman. The second is much more detailed and is for those who need to make thorough and precise studies of soils. Color terms are for dry soil unless otherwise stated. The profile described in the series is representative for mapping units in that series. If the profile of a given mapping unit is different from the one described for the series, these differences are stated in describing the mapping unit, or they are differences that are apparent in the name of the mapping unit.

As mentioned in the section "How This Survey Was Made," not all mapping units are members of a soil series. Aquents, for example, do not belong to a soil series, but nevertheless, are listed in alphabetic order along with the soil series.

Preceding the name of each mapping unit is a symbol. This symbol identifies the mapping unit on the detailed soil map. Listed at the end of each description of a mapping unit is the capability unit and range site to which the mapping unit is assigned. The page for the description of each mapping unit can be found in the "Index to Mapping Units."

The names, descriptions, and delineations of soil in this published soil survey do not always agree or join fully with soil maps of adjoining counties published at an earlier date. Differences are brought about by better knowledge about soils or modification and refinements in soil series concepts. In addition, the correlation of a recognized soil is based upon the acreage of that soil and the dissimilarity to adjacent soils within the survey area. Frequently, it is more feasible to include soils, small in extent, with similar soils, where management and response is much the same, rather than set them apart as individuals. The soil descriptions reflect these combinations. Other differences are brought about by the predominance of different soils in taxonomic units made up by two or three series. Still another difference may be caused by the range in slope allowed within the mapping unit for each survey.

The acreage and proportionate extent of each mapping unit are shown in table 1.

Many of the terms used in describing soils can be found in the "Glossary" at the end of this survey, and more detailed information about the terminology and methods of soil mapping can be obtained from the Soil Survey Manual (*7*).[1]

Aquents

Ac—Aquents are somewhat poorly drained, nearly level to sloping, coarse textured to moderately fine textured soils along and around the edges of lakes, intermittent lakes, marshes, and some large depressions. The surface layer is thin. It is dominantly sandy loam or loam, but in some places it is loamy sand or clay loam. It is underlain by unweathered parent material.

Aquents are low in organic-matter content and plant nutrients. They are subject to flooding. In some areas they are moderately or strongly saline. In others, they are moderately stony or gravelly.

Nearly all the acreage is used for pasture. Part of it has been cultivated. Management is needed to maintain good stands of native grass. Capability unit VIw-SL; range site not assigned.

Aquolls

Af—Aquolls are in large, deep closed depressions, mainly in the Missouri Coteau physiographic area of the county. The areas are covered by water most of the time, except during periods of prolonged drought. Cattails, bulrushes, reeds, and sedges grow along the margins where the water is shallow. Open water is nearly always in the center. The surface layer is thick and black. The underlying material is glacial till, local alluvium, and lake sediment that range from loamy fine sand to clay. The organic-matter content is high.

Aquolls have no agricultural value, except to supply water for livestock. Aquolls are important for waterfowl and other wildlife. Capability class VIIIw-1; range site not assigned.

Arnegard Series

The Arnegard series consists of deep, nearly level to moderately sloping, well drained loams. These soils formed in alluvium in swales.

In a representative profile the surface layer is dark grayish brown loam about 11 inches thick. The friable subsoil, about 14 inches thick, is dark grayish brown loam. The underlying material is mottled light brownish gray and grayish brown loam.

Permeability is moderate, and available water capacity is high. The organic-matter content is high. Fertility is high.

Most of the acreage is in crops. The native vegetation is mid and short prairie grasses.

Representative profile of Arnegard loam, 1 to 3 percent slopes, in cultivated field 2,160 feet north and 480 feet east of southwest corner sec. 3, T. 147 N., R. 86 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate medium granular structure; soft, friable, slightly sticky

[1] Italic numbers in parenthesis refer to Literature Cited, p. 216.

TABLE 1.—*Acreage and proportionate extent of the soils*

Map symbol	Soil name	Acres	Percent
Ac	Aquents	720	0.1
Af	Aquolls	10,300	0.8
ArA	Arnegard loam, 1 to 3 percent slopes	9,900	0.8
ArB	Arnegard loam, 3 to 6 percent slopes	1,950	0.2
ArC	Arnegard loam, 6 to 9 percent slopes	483	(1)
Ba	Banks loamy fine sand	1,350	0.1
Bk	Banks loam	690	0.1
BoA	Bowbells loam, 1 to 3 percent slopes	17,100	1.3
BsB	Bowbells-Williams loams, 3 to 6 percent slopes	8,700	0.7
BwA	Bowdle loam, 1 to 3 percent slopes	17,600	1.3
ByB	Bowdle-Stady loams, 3 to 6 percent slopes	8,400	0.6
ByC	Bowdle-Stady loams, 6 to 9 percent slopes	538	(1)
CaE	Cabba complex, 15 to 35 percent slopes	5,600	0.4
CbF	Cabba-Shale outcrop complex, 25 to 60 percent slopes	1,180	0.1
ChD	Cohagen-Vebar complex, 9 to 15 percent slopes	4,900	0.4
ChE	Cohagen-Vebar complex, 15 to 35 percent slopes	2,730	0.2
Co	Colvin silty clay loam	3,330	0.3
Dm	Dimmick clay	1,250	0.1
Dv	Divide loam	1,950	0.1
FaA	Falkirk loam, 1 to 3 percent slopes	22,800	1.7
FaB	Falkirk loams, 3 to 6 percent slopes	3,800	0.3
FbA	Falkirk and Max loams, 1 to 3 percent slopes	13,300	1.0
FbB	Falkirk and Max loams, 3 to 6 percent slopes	17,300	1.3
FbC	Falkirk and Max loams, 6 to 9 percent slopes	1,150	0.1
FfA	Farnuf loam, 1 to 3 percent slopes	437	(1)
FfB	Farnuf loam, 3 to 6 percent slopes	1,050	0.1
FlD	Flasher fine sandy loam, 6 to 15 percent slopes	560	(1)
FlE	Flasher fine sandy loam, 15 to 35 percent slopes	570	(1)
FnA	Flaxton fine sandy loam, 1 to 3 percent slopes	1,100	0.1
FnB	Flaxton fine sandy loam, 3 to 6 percent slopes	5,300	0.4
FnC	Flaxton fine sandy loam, 6 to 9 percent slopes	1,250	0.1
Fs	Fossum fine sandy loam	222	(1)
GaA	Grail silty clay loam, 1 to 3 percent slopes	5,600	0.4
GaB	Grail silty clay loam, 3 to 6 percent slopes	770	0.1
Gn	Grano silty clay	620	0.1
GoA	Grassna silt loam, 1 to 3 percent slopes	2,100	0.2
HaA	Hamerly loam, 1 to 3 percent slopes	2,450	0.2
Hk	Harriet-Saline land complex	13,500	1.0
Hn	Havrelon very fine sandy loam	4,850	0.4
Ho	Havrelon silty clay loam	4,900	0.4
Hs	Heil silty clay loam	680	0.1
KrB	Krem loamy fine sand, 1 to 6 percent slopes	550	(1)
La	Lallie soils	1,030	0.1
LeB	Lihen loamy fine sand, 1 to 6 percent slopes	2,960	0.2
LeC	Lihen loamy fine sand, 6 to 9 percent slopes	485	(1)
LgE	Lihen-Zahl complex, 9 to 25 percent slopes	830	0.1
LmB	Linton-Mandan silt loams, 3 to 6 percent slopes	990	0.1
LmC	Linton-Mandan silt loams, 6 to 9 percent slopes	358	(1)
LmD	Linton-Mandan silt loams, 9 to 15 percent slopes	186	(1)
LmE	Linton-Mandan silt loams, 15 to 40 percent slopes	209	(1)
Lw	Lohler silty clay loam	970	0.1
Ly	Lohler silty clay	187	(1)
Ma	Makoti silty clay loam	13,300	1.0
MdA	Mandan silt loam, 1 to 3 percent slopes	8,300	0.6
MdB	Mandan silt loam, 3 to 6 percent slopes	5,900	0.5
MdC	Mandan silt loam, 6 to 9 percent slopes	1,200	0.1
Mf	Marysland loam	4,100	0.3
MgB	Max loam, 3 to 6 percent slopes	51,600	3.9
MhC	Max-Bowbells-Zahl loams, 6 to 9 percent slopes	4,100	0.3
MlC	Max-Zahl loams, 6 to 9 percent slopes	112,300	8.5
MlD	Max-Zahl loams, 9 to 15 percent slopes	44,750	3.4
MoC	Morton loam, 3 to 9 percent slopes	900	0.1
NbA	Niobell-Williams loams, 1 to 3 percent slopes	1,600	0.1
NbB	Niobell-Williams loams, 3 to 6 percent slopes	570	(1)
NmB	Noonan-Miranda complex, 1 to 6 percent slopes	920	0.1
NmD	Noonan-Miranda complex, 6 to 15 percent slopes	329	(1)
NtA	Nutley silty clay, 1 to 3 percent slopes	560	(1)
NtB	Nutley silty clay, 3 to 6 percent slopes	540	(1)
Or	Orthents, loamy	1,050	0.1
Pa	Parnell silty clay loam	19,700	1.5
Pe	Parnell silty clay loam, very wet	6,890	0.5
PhA	Parshall fine sandy loam, 1 to 3 percent slopes	3,450	0.3
PhB	Parshall fine sandy loam, 3 to 6 percent slopes	5,300	0.4
PhC	Parshall fine sandy loam, 6 to 9 percent slopes	1,838	0.1
PhD	Parshall fine sandy loam, 9 to 15 percent slopes	480	(1)
PoA	Parshall loam, 1 to 3 percent slopes	1,750	0.1
PoB	Parshall loam, 3 to 6 percent slopes	1,700	0.1
RgC	Regent silty clay loam, 3 to 9 percent slopes	1,250	0.1
RhB	Rhoades complex, 1 to 9 percent slopes	2,450	0.2
Rm	Riverwash	322	(1)
Ro	Roseglen silt loam	13,600	1.0
RpB	Roseglen-Tansem complex, 3 to 6 percent slopes	1,900	0.1
RpC	Roseglen-Tansem complex, 6 to 9 percent slopes	202	(1)
RsA	Ruso coarse sandy loam, 1 to 3 percent slopes	14,900	1.1

TABLE 1.—*Acreage and proportionate extent of the soils*—Continued

Map symbol	Soil name	Acres	Percent
RtB	Ruso-Manning coarse sandy loams, 3 to 6 percent slopes	19,500	1.5
RtC	Ruso-Manning coarse sandy loams, 6 to 9 percent slopes	570	([1])
RxB	Ruso-Manning complex, 3 to 6 percent slopes	12,800	1.0
RyC	Ruso-Wabek complex, 6 to 9 percent slopes	1,350	0.1
RzA	Ruso soils, 1 to 3 percent slopes	6,900	0.5
SeD	Seroco fine sand, 9 to 25 percent slopes	142	([1])
Sn	Sinai silty clay	5,300	0.4
St	Straw loam	1,500	0.1
Sx	Straw soils, channeled	1,300	0.1
TlC	Telfer-Lihen loamy fine sands, 3 to 9 percent slopes	800	0.1
Tp	Tonka-Parnell complex	8,700	0.7
Tr	Trembles fine sandy loam	1,450	0.1
VwC	Vebar-Williams fine sandy loams, 3 to 9 percent slopes	1,600	0.1
WaB	Wabek-Max-Zahl loams, 1 to 6 percent slopes	630	0.1
WaD	Wabek-Max-Zahl loams, 6 to 15 percent slopes	3,600	0.3
WbB	Wabek soils, 1 to 6 percent slopes	5,300	0.4
WbD	Wabek soils, 6 to 15 percent slopes	13,800	1.0
WlB	Williams stony loam, 1 to 9 percent slopes	485	([1])
WmA	Williams clay loam, 1 to 3 percent slopes	2,500	0.2
WmB	Williams clay loam, 3 to 6 percent slopes	3,200	0.2
WoA	Williams-Bowbells loams, 1 to 3 percent slopes	142,500	10.8
WoB	Williams-Bowbells loams, 3 to 6 percent slopes	332,500	25.2
WoC	Williams-Bowbells loams, 6 to 9 percent slopes	34,400	2.6
WpB	Williams-Bowbells-Zahl loams, 3 to 6 percent slopes	12,200	0.9
WrB	Williams loam, mine sink, 1 to 6 percent slopes	227	([1])
WsA	Wilton silt loam, 1 to 3 percent slopes	14,100	1.1
WtB	Wilton-Temvik silt loams, 3 to 6 percent slopes	18,500	1.4
WwC	Wilton-Williams silt loams, 6 to 9 percent slopes	4,800	0.4
ZcE	Zahl-Cabba complex, 15 to 35 percent slopes	31,400	2.4
ZmE	Zahl-Max loams, 9 to 35 percent slopes	61,500	4.7
ZpE	Zahl-Max-Parnell complex, 15 to 35 percent slopes	16,100	1.2
ZwC	Zahl-Williams loams, 3 to 9 percent slopes	12,900	1.0
	Cut and fill land	1,460	0.1
	Gravel pits	800	0.1
	Intermittent lake	3,100	0.2
	Lake	4,200	0.3
	Total	1,321,600	100.0

[1] Less than 0.1 percent.

and slightly plastic; slightly acid; abrupt smooth boundary.

A12—6 to 11 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate medium subangular blocky structure parting to moderate medium granular; soft, friable, slightly sticky and slightly plastic, neutral; gradual wavy boundary.

B2—11 to 25 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate medium prismatic structure parting to weak fine subangular blocky; soft, friable, slightly sticky and slightly plastic; neutral; abrupt wavy boundary.

C1ca—25 to 40 inches; light brownish gray (2.5Y 6/2) loam, grayish brown (2.5Y 5/2) when moist; few fine faint mottles of gray (10YR 6/1); weak medium subangular blocky structure parting to weak fine granular; slightly hard, friable, slightly sticky and slightly plastic; strong effervescence; mildly alkaline; diffused wavy boundary.

C2—40 to 50 inches; grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) when moist; few fine distinct brown to dark brown (10YR 4/3) mottles that are common fine distinct gray (5Y 5/1) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; slight effervescence; mildly alkaline; diffused wavy boundary.

C3—50 to 60 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) when moist; common medium distinct gray (5Y 5/1) and few medium prominent yellowish red (5YR 4/8) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; slight effervescence; mildly alkaline.

The A horizon is typically loam, but is silt loam in places. The B horizon ranges from loam and light clay loam to silt loam. The C horizon is generally calcareous above 40 inches. It ranges from sandy loam to clay loam. It formed in local alluvium from glacial till or deeply weathered soft shale.

Arnegard soils are associated in the landscape with Williams, Max, and Zahl soils. They formed in alluvium, and the associated soils formed in glacial till.

ArA—Arnegard loam, 1 to 3 percent slopes. This soil occurs as long narrow areas in drainageways and swales in the uplands. It has the profile described as representative of the series. Included in mapping were small areas of Williams, Bowbells, Falkirk, Grail, Parnell, and Zahl soils.

This soil has slow runoff and is only slightly susceptible to erosion. It is suited to all crops commonly grown in the county. The chief management needs are

conserving moisture and maintaining fertility and tilth. Most of the acreage is in crops. A few areas are in native range. Capability unit IIc–6; Overflow range site.

ArB—Arnegard loam, 3 to 6 percent slopes. This soil occurs as long narrow areas in swales and on foot slopes. Included in mapping were small areas of Williams, Bowbells, Grail, Falkirk, Tonka, Parnell, and Zahl soils.

This soil has slow runoff and is slightly susceptible to water erosion. It is suited to all crops commonly grown in the county. The main management concerns are controlling erosion, conserving moisture, and maintaining fertility and tilth. Most of the acreage is in crops. A few areas are in native range. Capability unit IIe–6; Silty range site.

ArC—Arnegard loam, 6 to 9 percent slopes. This soil occurs as long narrow areas on concave foot slopes or in swales. It is about 75 percent Arnegard soils and 25 percent Williams and Bowbells soils. Included with this soil in mapping were small areas of Grail, Zahl, Max, and Cabba soils.

This soil has slow to medium runoff and is moderately susceptible to erosion. It is suited to all crops commonly grown in the county. The chief management needs are controlling erosion, conserving moisture, and maintaining fertility and tilth. About half the acreage is in crops. The rest is in native range or pasture. Capability unit IIIe–6; Silty range site.

Banks Series

The Banks series consists of deep, level, somewhat excessively drained soils on low terraces and bottom lands. These soils formed in sandy and loamy alluvium.

In a representative profile the surface layer is grayish brown loamy fine sand about 4 inches thick. The underlying material is light brownish gray loamy fine sand, loam, and fine sand. It is calcareous and has several thin stratifications of loam.

Permeability is moderately rapid or rapid in the surface layer and rapid in the underlying material. Available water capacity, organic-matter content, and natural fertility are low.

Nearly all the acreage is in native vegetation. A few areas are cultivated. Banks soils support a variety of vegetative types ranging from a sparse stand of native grasses to a fair stand of cottonwood and willow. The understory is grasses and shrubs.

Representative profile of Banks loamy fine sand in native vegetation 2,000 feet west and 600 feet north of southeast corner sec. 5, T. 143 N., R. 81 W.

A1—0 to 4 inches; grayish brown (2.5Y 5/2) loamy fine sand, dark grayish brown (2.5Y 4/2) when moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; slight effervescence; neutral abrupt boundary.

C1—4 to 33 inches; light brownish gray (2.5Y 6/2) fine sand, dark grayish brown (2.5Y 4/2) when moist; single grained; loose, nonsticky and nonplastic, slight effervescence; mildly alkaline; abrupt boundary.

C2—33 to 36 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) when moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; strong effervescence; mildly alkaline; abrupt boundary.

C3—36 to 44 inches; light brownish gray (2.5Y 6/2) fine sand, dark grayish brown (2.5Y 4/2) when moist; single grained; loose, nonsticky and nonplastic; strong effervescence; mildly alkaline; abrupt boundary.

C4—44 to 52 inches; light brownish gray (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) when moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; strong effervescence; mildly alkaline; abrupt boundary.

C5—52 to 60 inches; light brownish gray (2.5Y 6/2) loamy fine sand, dark grayish brown (2.5Y 4/2) when moist; single grained; loose, nonsticky and nonplastic; strong effervescence; mildly alkaline.

The A horizon is 2 to 7 inches thick and is grayish brown or light brownish gray. It is typically loam or loamy fine sand, but the range includes clay loam.

The C horizon ranges from grayish brown to light gray. It is mainly strata of loamy fine sand and fine sand. Several strata ¼ inch to 8 inches thick ranging from clay loam to sandy loam occur in the C horizon. Strata of gravelly material are in a few places.

Banks soils are associated in the landscape with Trembles, Haverlon, and Seroco soils. They contain more sand throughout the profile than Trembles and Haverlon soils, and they have a stratified C horizon lacking in Seroco soils.

Ba—Banks loamy fine sand. This level soil is on bottom land and low terraces. It has the profile described as representative of the series. Slopes are 0 to 1 percent. Areas are irregular in shape and occur as long stringers. Included in mapping were small areas of Trembles fine sandy loam, Havrelon loam, and Banks loam.

This soil has very slow runoff. It is subject to flooding when ice jams occur in spring. At other times it is effectively protected by the Garrison Dam.

Nearly all the acreage is used for grazing. A few areas are cultivated but should be seeded to grass. Soil blowing is a hazard if the plant cover is removed. Management is needed to maintain a good stand of grass. Capability unit VIe–2; range site not assigned.

Bk—Banks loam. This level soil is on bottom land and low terraces. It occurs as long irregular stringers. Slopes are 0 to 1 percent. The profile is similar to the one described as representative of the series, but the surface layer is loam 6 to 10 inches thick.

Included in mapping were small areas of Banks loamy fine sand, Trembles fine sandy loam, and Havrelon loam. Also included were a few areas where the loam is 10 to 25 inches thick.

This soil has very slow runoff. Permeability is moderately rapid in the loam material and rapid below. Soil blowing is a hazard if the plant cover is removed. Garrison Dam effectively protects this soil from flooding unless ice jams occur in spring.

This soil is suited to small grain and alfalfa. About

half the acreage is cleared and used for crops. The rest is in native vegetation. The chief management concerns are controlling soil blowing, conserving moisture, and maintaining fertility and tilth. Capability unit IVe-5L; range site not assigned.

Bowbells Series

The Bowbells series consists of deep, nearly level to gently rolling, moderately well drained loams. These soils formed in glacial till.

In a representative profile the surface layer is dark grayish brown loam about 9 inches thick. The subsoil, about 16 inches thick, is dark grayish brown loam in the upper 8 inches and grayish brown firm clay loam in the lower 8 inches. The underlying material is light brownish gray and light yellowish brown clay loam.

Permeability is moderate in the subsoil and moderately slow in the underlying material. Available water capacity is high. The organic-matter content is high. Natural fertility is high.

Most of the acreage is cultivated and used for small grain and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Bowbells loam, 1 to 3 percent slopes, in cultivated field 30 feet north and 200 feet east of southwest corner sec. 26, T. 144 N., R. 80 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; weak fine granular structure; hard, very friable, slightly sticky and slightly plastic; slightly acid; abrupt boundary.

B21—9 to 17 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; weak coarse prismatic structure parting to moderate coarse angular blocky; hard, very friable, slightly sticky and slightly plastic; many very fine pores, mildly acid; clear boundary.

B22t—17 to 23 inches; grayish brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) when moist; moderate medium prismatic structure parting to strong medium angular blocky; hard, firm, sticky and plastic; common very fine pores; continuous clay films; neutral; clear boundary.

B3ca—23 to 25 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; weak coarse prismatic structure parting to strong medium and coarse angular blocky; hard, friable, sticky and plastic; common very fine pores; patches of clay films; slight effervescence; neutral; clear boundary.

C1ca—25 to 30 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; massive; hard, friable, slightly sticky and slightly plastic; common very few pores; few soft masses and few threads of lime; violent effervescence; mildly alkaline; gradual boundary.

C2—30 to 47 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; massive; hard, friable, slightly sticky and slightly plastic; few threads and soft masses of lime; violent effervescence; mildly alkaline; gradual boundary.

C3—47 to 60 inches; light yellowish brown (2.5Y 6/3) clay loam, olive brown (2.5Y 4/3) when moist; massive; hard, friable, slightly sticky and slightly plastic; few soft masses of lime; strong effervescence; mildly alkaline.

The A horizon is typically loam but in places is silt loam or clay loam. The C horizon is loam or clay loam.

Bowbells soils are associated in the landscape with Williams and Max soils. They are not so well drained as those soils.

BoA—Bowbells loam, 1 to 3 percent slopes. This nearly level soil is in broad swales and concave areas. Included in mapping were small areas of Williams, Tonka, Parnell, Arnegard, and Max soils.

This soil has slow runoff and is only slightly susceptible to erosion. It is used mostly for crops and is suited to all crops commonly grown in the county. The chief management needs are conserving moisture and maintaining fertility and tilth. Capability unit IIc-6; Overflow range site.

BsB—Bowbells-Williams loams, 3 to 6 percent slopes. This undulating to gently sloping mapping unit occupies swales in the uplands. It is 60 percent Bowbells loam and 40 percent Williams loam. Williams soil is on the higher and slightly convex slopes. Included in mapping were small areas of Tonka, Parnell, Arnegard, and Max soils.

This mapping unit has slow runoff and is slightly susceptible to erosion. It is used mostly for crops and is suited to all crops commonly grown in the county. The chief management concerns are controlling erosion, conserving moisture, and maintaining fertility and tilth. Capability unit IIe-6; Silty range site.

Bowdle Series

The Bowdle series consists of nearly level to gently rolling, well drained soils that are moderately deep over sand and gravel. These soils formed in loamy material underlain by sand and gravel glacial outwash.

In a representative profile the surface layer is dark grayish brown loam about 13 inches thick. The very friable subsoil, about 19 inches thick, is dark grayish brown loam in the upper 15 inches and grayish brown loam in the lower 10 inches. The underlying material is light brownish gray gravelly loamy sand.

Permeability is moderate in the subsoil and very rapid in the underlying material. Available water capacity is moderate. The organic-matter content is high. Natural fertility is medium.

Most of the acreage is cultivated and used for small grain, corn, and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Bowdle loam, 1 to 3 percent slopes, in cultivated field 550 feet east and 30 feet south of northwest corner sec. 10, T. 143 N., R. 80 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; neutral; abrupt boundary.

A12—7 to 13 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; weak medium prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; neutral; gradual boundary.

B21—13 to 22 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate medium prismatic structure parting to moderate medium blocky; slightly hard, very friable, slightly sticky and slightly plastic; many very fine pores; patches of clay films; neutral; gradual boundary.

B22—22 to 28 inches; grayish brown (10YR 5/2) heavy loam, very dark grayish brown (10YR 3/2) when moist; moderate medium prismatic structure parting to moderate medium blocky; slightly hard, very friable, slightly sticky and slightly plastic; many fine pores; thin continuous clay films; neutral; clear wavy boundary.

B3ca—28 to 32 inches; grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) when moist; weak medium prismatic structure; slightly hard and slightly plastic; common very fine pores; common gravel; strong effervescence; mildly alkaline; clear wavy boundary.

IIC1—32 to 48 inches; light brownish gray (2.5Y 6/2) gravelly loamy sand, light olive brown (2.5Y 5/3) when moist; single grained; loose, nonsticky and nonplastic; violent effervescence; mildly alkaline.

The Bowdle soils in McLean County have a slightly drier moisture regime than is described as typical of the series.

The A horizon is 6 to 8 inches thick and ranges from very dark gray to dark grayish brown. It is typically loam, but in places is clay loam.

The B horizon is 5 to 20 inches thick and is dark grayish brown or grayish brown. It is loam or light clay loam. Clay films occur in some pedons. The B3 horizon is lacking in places. Depth to carbonates ranges from 20 to 40 inches.

Depth to the IIC horizon is typically about 30 inches, but ranges from 20 to 40 inches. The texture ranges from gravelly loamy sand to gravel. A weakly to moderately expressed horizon of lime accumulation is in the upper part of the IIC horizon.

Bowdle soils are associated in the landscape with Stady soils. They have a thicker A horizon than Stady soils.

BwA—Bowdle loam, 1 to 3 percent slopes. This nearly level soil occurs as broad smooth areas. Areas are small to large in size and irregular in shape. This soil has the profile described as representative of the series (fig. 8). Included in mapping were small areas of Stady, Arnegard, and Wabek soils. In a few spots the soil is moderately or strongly affected by salts. In some the surface is gravelly.

This soil has slow runoff and is only slightly susceptible to erosion. It is suited to all crops commonly grown in the county. Most areas are used for crops. The chief management needs are conserving moisture and maintaining fertility and tilth. Capability unit IIIs-6; Silty range site.

ByB—Bowdle-Stady loams, 3 to 6 percent slopes. This undulating to gently sloping mapping unit is about 70 percent Bowdle loam and 30 percent Stady loam. The Stady soil has the profile described as representative of the series. It has a thinner surface layer than Bowdle loam. It is in slightly convex parts of the landscape. Included in mapping were small areas of

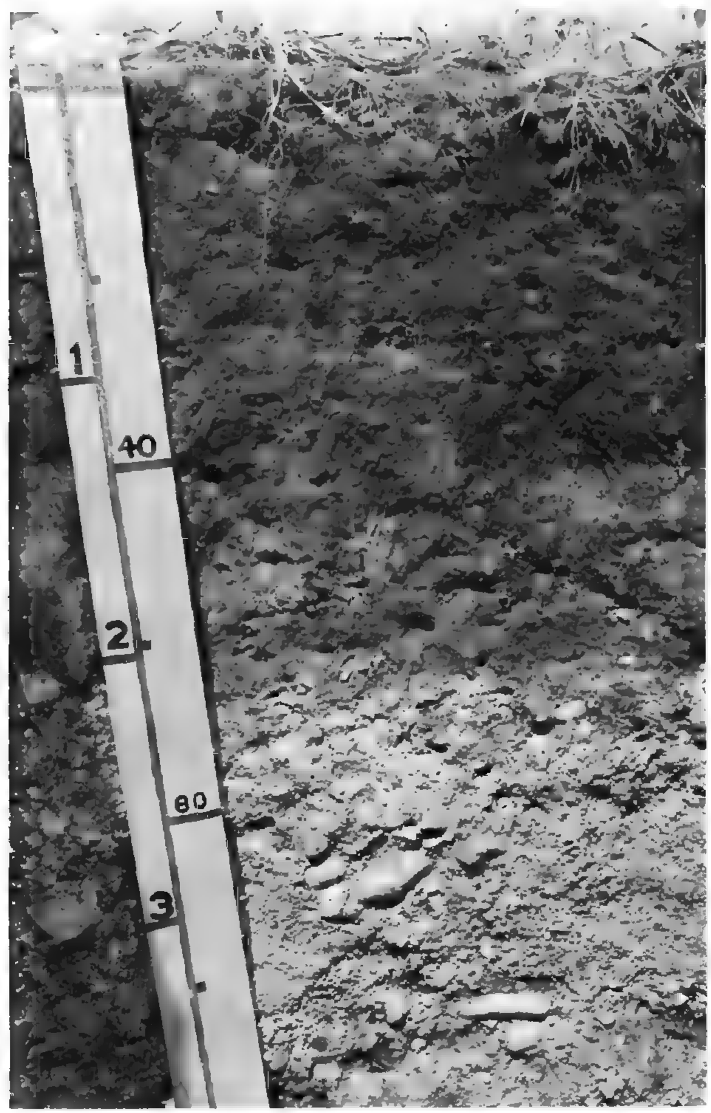

Figure 8.—Profile of Bowdle loam showing gravelly loamy sand at a depth of 32 inches.

Arnegard, Ruso, and Wabek soils. In spots, the surface is gravelly.

This mapping unit is well drained, has slow or medium runoff, and is moderately susceptible to erosion. It is used mostly for crops and is suited to all crops commonly grown in the county. The chief management needs are controlling erosion, conserving moisture, and maintaining fertility and tilth. Capability unit IIIes–6; Silty range site.

ByC—Bowdle-Stady loams, 6 to 9 percent slopes. This gently rolling to moderately sloping mapping unit is about 60 percent Bowdle loam, 35 percent Stady loam, and 5 percent Wabek loam. The Stady loam has a thinner surface layer than Bowdle loam. It is on the upper slopes and convex parts of the landscape. Included in mapping are small areas of Arnegard and Ruso soils. In spots the surface is gravelly.

This mapping unit has medium runoff and is highly susceptible to erosion. It has medium fertility. It is suited to all crops commonly grown in the county. More than half the acreage is cropped. The main concerns of management are controlling erosion, conserving moisture, and maintaining fertility and tilth. Capability unit IVes–6; Silty range site.

Cabba Series

The Cabba series consists of shallow, hilly to very steep, well drained loams on hills and ridges in uplands. These soils formed in calcareous, soft loamy shale beds.

In a representative profile the surface layer is grayish brown loam about 3 inches thick. The underlying material is light gray loam to 17 inches. Shale is at 17 inches.

These soils have very rapid runoff. Permeability is moderate. Available water capacity, the organic-matter content, and fertility are low.

Nearly all the acreage is in native range. A few small areas are cultivated. The native vegetation is mid and short prairie grasses.

Representative profile of Cabba loam in grassy area of Cabba-Shale outcrop complex, 25 to 60 percent slopes, 1,500 feet north and 550 feet east of southwest corner sec. 13, T. 144 N., R. 84 W.

A1—0 to 3 inches; grayish brown (2.5Y 5/2) loam, very dark grayish brown (2.5Y 3/2) when moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; slight effervescence; mildly alkaline; clear boundary.

C1—3 to 17 inches; light gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) when moist; weak medium prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; strong effervescence; mildly alkaline; gradual boundary.

C2—17 to 60 inches; pale yellow (5Y 7/3) soft loam shale, olive (5Y 5/3) when moist; moderate thick platy structure; hard, firm, slightly sticky and slightly plastic; few roots; strong effervescence; moderately alkaline.

The A horizon is grayish brown or light brownish gray and 2 to 5 inches thick. It ranges from very fine sandy loam to silty clay loam. It lacks free lime in some pedons and has strong effervescence in others.

The C1 horizon ranges from grayish brown to light gray or pale yellow. The texture is loam or silt loam.

The C2 horizon is soft, massive or platy, fine grained sandstone, or interbedded sandstone, siltstone, and shale. The depth to soft shale ranges from 10 to 20 inches.

Cabba soils are associated in the landscape with Morton and Zahl soils and are less deep than those soils.

CaE—Cabba complex, 15 to 35 percent slopes. This hilly and steep mapping unit is on uplands. It is about 40 percent Cabba loam, 25 percent a soil resembling Cabba loam but with a clay loam and clay texture, 10 percent Cohagen soil, and 25 percent minor soils. Some of the minor soils are Regent, Morton, Vebar, Arnegard, and Zahl soils on smooth slopes, swales, and foot slopes.

This mapping unit has very rapid runoff and is very susceptible to erosion. The entire area is used for grazing. Management is needed to maintain the stands of native grass. Capability unit VIe–Sw; Shallow range site.

CbF—Cabba-Shale outcrop complex, 25 to 60 percent slopes. This steep and very steep mapping unit is on uplands. It occurs as narrow rounded ridge crests between steep drainageways. It is about 50 percent Cabba loam, 30 percent barren or nearly barren Shale outcrop, and about 20 percent minor soils. The Cabba soil has the profile described as representative of the series. The texture and depth to shale range greatly within short distances, depending on the kind of shale. Layers of sandstone and clayey shale occur in this unit. Included in mapping were small areas of Morton, Zahl, Regent, Williams, Wilton, Temvik, Mandan, Arnegard, Grail, Vebar, and Straw soils on smoother slopes.

This unit has very rapid runoff and is very susceptible to erosion. The entire area is used for range. Management is needed to maintain the stands of native grass. Capability unit VIIe–Sw; Cabba soil in Shallow range site; Shale outcrop, range site not assigned.

Cohagen Series

The Cohagen series consists of shallow, strongly sloping to steep, well drained, loamy soils. These soils are on hills, ridges, and steep slopes on uplands. They formed in calcareous soft sandstone.

In a representative profile the surface layer is grayish brown loam about 3 inches thick. The underlying material is grayish brown and light brownish gray sandy loam. Sandstone is at 18 inches.

Permeability is moderately rapid. The available water capacity, the organic-matter content, and fertility are low.

Most areas are in native grass and are best suited for this purpose. The native vegetation is mid and short prairie grasses.

Representative profile of Cohagen loam in grassy area of Cohagen-Vebar complex, 9 to 15 percent slopes,

2,300 feet south and 1,050 feet west of northeast corner sec. 8, T. 148 N., R. 90 W.

A1—0 to 3 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and nonplastic; many roots; neutral; clear boundary.

AC—3 to 8 inches; grayish brown (2.5Y 5/2) sandy loam, dark grayish brown (2.5Y 4/2) when moist; weak medium subangular blocky structure parting to moderate fine granular; slightly hard, very friable, nonsticky and nonplastic; many roots; neutral; clear boundary.

C1—8 to 18 inches; light brownish gray (2.5Y 6/2) sandy loam, grayish brown (2.5Y 5/2) when moist; weak coarse prismatic structure parting to weak coarse subangular blocky; slightly hard, very friable, nonsticky and nonplastic; common roots; few threads of segregated lime; strong effervescence; mildly alkaline; gradual boundary.

C2—18 to 60 inches; light gray (2.5Y 7/2) soft sandstone, light olive brown (2.5Y 5/4) when moist; massive; tendency to separate on bedding plains; slightly hard, very friable, nonsticky and nonplastic; few seams of segregated lime in upper few inches; strong effervescence; mildly alkaline.

The A horizon is 2 to 5 inches thick and is dominantly grayish brown. It is fine sandy loam, sandy loam, or loam. Effervescence is none to strong.

The C horizon ranges from light gray to olive yellow. It is sandy loam or fine sandy loam.

The underlying material is soft, massive or platy, fine grained sandstone. The depth to soft sandstone ranges from 10 to 20 inches.

Cohagen soils are associated in the landscape with Vebar, Cabba, and Flasher soils. They are less deep than Vebar soils, contain more sand than Cabba soils, and contain less sand than Flasher soils.

ChD—Cohagen-Vebar complex, 9 to 15 percent slopes. This strongly sloping and rolling mapping unit is on uplands. It is about 55 percent Cohagen soil on ridges, 25 percent Vebar soil on gentler slopes, and 20 percent Parshall and Flasher soils. The surface layer ranges from loam to fine sandy loam and sandy loam. The Cohagen soil has the profile described as representative of the Cohagen series. Included in mapping were small areas of Arnegard, Cabba, Temvik, Williams, and Zahl soils.

This unit has medium runoff. Fertility is low in the Cohagen soil and medium in the Vebar soil.

Nearly all the acreage is in native grass. Management is needed to maintain good stands. Capability unit VIe–Sw; Cohagen soil in Shallow range site; Vebar soil in Sandy range site.

ChE—Cohagen-Vebar complex, 15 to 35 percent slopes. This hilly and steep mapping unit is on uplands. It is about 50 percent Cohagen soil on steeper ridges, 20 percent Vebar soils on smoother slopes, and 30 percent Cabba, Flasher, and Parshall soils. The surface layer ranges from fine sandy loam to loam and sandy loam. Included in mapping were small areas of Arnegard, Temvik, Morton, Williams, and Zahl soils.

This unit has medium runoff. Fertility is low in the Cohagen soil and medium in the Vebar soils.

All the acreage is used for range. Management is needed to maintain good stands of native grass. Capability unit VIe–Sw; Cohagen soil in Shallow range site; Vebar soil in Sandy range site.

Colvin Series

The Colvin series consists of poorly drained, deep, level, calcareous soils. These soils are in shallow depressions and swales, in melt-water channels, and on glacial lake plains and outwash plains. They formed in moderately fine textured melt-water deposits and lake sediment.

In a representative profile the surface layer is dark gray silty clay loam about 9 inches thick. In sequence downward, the underlying material is light gray, friable silty clay loam; 14 inches of mottled light gray silty clay loam; 16 inches of mottled dark gray clay loam; and 2 inches of mottled light yellowish brown sandy loam.

Permeability is moderate or moderately slow. The water table is at or near the surface in spring and after heavy rains and is within 2 to 4 feet throughout most of the growing season. Available water capacity and organic-matter content are high. Natural fertility is medium.

Most of the acreage is used for native range or hay. If drained, these soils are suited to crops.

Representative profile of Colvin silty clay loam in native vegetation 2,740 feet south and 350 feet east of northwest corner sec. 22, T. 148 N., R. 81 W.

A1—0 to 9 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) when moist; moderate fine granular structure; hard, friable, sticky and plastic; many fine roots; strong effervescence; moderately alkaline; clear wavy boundary.

C1ca—9 to 28 inches; light gray (N 7/0) silty clay loam, gray (5Y 4/1) when moist; weak coarse subangular blocky structure; hard, friable, slightly sticky and plastic; common fine roots; common fine pores; violent effervescence; mildly alkaline; gradual wavy boundary.

C2ca—28 to 42 inches; light gray (5Y 7/1) silty clay loam, gray (5Y 4/1) when moist; few fine distinct light olive brown (2.5Y 5/4) mottles; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and plastic; few fine roots; many fine pores; violent effervescence; mildly alkaline; clear wavy boundary.

C3g—42 to 58 inches; dark gray (5Y 4/1) clay loam, very dark gray (5Y 3/1) when moist; few fine distinct light yellowish brown (2.5Y 6/4) mottles; massive; very hard, firm, sticky and plastic; slight effervescence; neutral; clear boundary.

IIC4g—58 to 60 inches; light yellowish brown

(2.5Y 6/4) sandy loam, greenish gray (5GY 5/1) when moist; many large prominent brownish yellow (10YR 6/8) mottles; massive; hard, friable, nonsticky and nonplastic; about 5 percent gravel; slight effervescence; mildly alkaline.

The A horizon is 6 to 14 inches thick. It is commonly silty clay loam, but in places is silt loam. It ranges from weakly to strongly calcareous.

The Cca horizon ranges from 6 to 35 inches and from light gray to gray. Below a depth of 40 inches the texture ranges from silty clay to coarse sand. Crystals of soluble salts and gypsum occur throughout the profile in some places.

Colvin soils are associated in the landscape with Hamerly and Parnell soils. They are not so well drained as Hamerly soils. They have more lime than Parnell soils.

Co—Colvin silty clay loam. This is the only Colvin soil mapped in the county. Slopes are 0 to 1 percent. Included in mapping were small areas of Grano, Marysland, Divide, Arnegard, and other soils.

This soil is poorly drained. Runoff is slow or very slow. The water table is at or near the surface in spring and after heavy rainfall.

Most of the acreage is used for native range or hay. A few areas have been drained and are used for small grain and alfalfa. Colvin soils are well suited to farming if excess water is removed. The chief management concerns are water control, erosion control, and maintenance of fertility and tilth. Capability unit IIw–4L; Wet Meadow range site.

Dimmick Series

The Dimmick series consists of deep, level, very poorly drained clay soils in basins and depressions. These soils formed in alluvium.

In a representative profile the surface layer is dark gray and gray clay about 10 inches thick. The underlying material is mottled gray clay.

Permeability is very slow. Available water capacity is moderate. The organic-matter content is high. Natural fertility is medium.

Most of the acreage is used for pasture and hay.

Representative profile of Dimmick clay in cropland 1,800 feet east and 2.300 feet north of southwest corner sec. 19, T. 146 N., R. 81 W.

A11—0 to 3 inches; dark gray (10YR 4/1) clay, black (10YR 2/1) when moist; weak medium angular blocky structure parting to moderate medium granular; hard, friable, sticky and plastic; common very fine roots; slightly acid; clear boundary.

A12—3 to 10 inches; gray (10YR 5/1) clay, black (10YR 2/1) when moist; common medium distinct yellowish brown (10YR 5/6) mottles; weak coarse angular blocky structure; very hard, firm, sticky and plastic; common very fine roots; slightly acid; clear boundary.

C1g—10 to 24 inches; gray (10YR 5/1) clay, black (10YR 2/1) when moist; few fine faint yellowish brown (10YR 5/4) mottles; massive; very hard, firm, sticky and plastic; few fine roots; neutral; gradual boundary.

C2g—24 to 30 inches; gray (10YR 5/1) clay, black (10YR 2/1) when moist; few fine faint yellowish brown (10YR 5/4) mottles; massive; very hard, very firm, sticky and plastic; few lime spots; slight effervescence; neutral; gradual boundary.

C3g—30 to 44 inches; gray (10YR 5/1) clay, very dark gray (10YR 3/1) when moist; few fine faint yellowish brown (10YR 5/4) mottles; massive; very hard, very firm, sticky and plastic; few lime spots; slight effervescence; neutral.

Texture is clay or silty clay. Faint, distinct, or prominent mottles of olive brown, yellowish brown, or dark yellowish brown are within 20 inches of the surface in most pedons. A few pedons have low chroma throughout. The depth to carbonates is 24 to 60 inches.

Dimmick soils are associated in the landscape with Grano, Sinai, and Heil soils. They have less lime than Grano soils and are not so well drained as Sinai soils. They differ from Heil soils in not having columnar structure.

Dm—Dimmick clay. This is the only Dimmick soil mapped in the county. Slopes are 0 to 1 percent. Included in mapping were small areas of Parnell, Grano, Makoti, and other soils.

The soil is very poorly drained. It is ponded until midsummer in most years. Available water capacity is moderate. The organic-matter content is high. Natural fertility is medium.

This soil is used mostly for hay and pasture, unless it is drained. It is difficult to till because of excessive wetness in spring. It is very hard and cloddy when dry. A management concern is maintaining fertility and tilth. Capability unit IIIw–4; Wetland range site.

Divide Series

The Divide series consists of level, somewhat poorly drained soils that are moderately deep over sand and gravel. These soils formed in loam glacial outwash and gravel outwash.

In a representative profile the surface layer is dark gray and gray loam about 9 inches thick. The underlying material to a depth of 28 inches is very friable light gray loam containing a large amount of lime. Below this is stratified gravelly sand and gravelly loamy sand.

Permeability is moderate in the loamy upper material and very rapid in the gravel and sand. Available water capacity is low. The organic-matter content is high. Fertility is medium.

About half of the acreage is cultivated and used for small grain and alfalfa. Other areas are used for hay or pasture.

Representative profile of Divide loam in a cultivated field 1,400 feet north and 100 feet west of the southeast corner, sec. 7, T. 149 N., R. 84 W.

Ap—0 to 5 inches; dark gray (10YR 4/1) loam, black (10YR 2/1) when moist; moderate fine granular structure; slightly

hard, very friable, slightly sticky and slightly plastic; many fine roots; slight effervescence; moderately alkaline; abrupt smooth boundary.

A12—5 to 9 inches; gray (10YR 5/1) loam, black (10YR 2/1) when moist; weak medium subangular blocky structure; slightly hard, friable, slightly sticky and slightly plastic; many fine roots; common fine pores; slight effervescence; strongly alkaline; clear wavy boundary.

C1ca—9 to 22 inches; light gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) when moist; weak medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slighty sticky and slightly plastic; common fine roots; common fine pores; many soft masses of lime; violent effervescence; strongly alkaline; gradual wavy boundary.

C2ca—22 to 28 inches; light gray (2.5Y 7/2) loam, grayish brown (2.5Y 5/2) when moist; few medium distinct yellowish brown (10YR 5/4) mottles; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few fine roots; common fine pores; common soft masses of lime; violent effervescence; strongly alkaline; clear wavy boundary.

IIC3—28 to 34 inches; light yellowish brown (2.5Y 6/3) gravelly loamy sand, light olive brown (2.5Y 5/3) when moist; single grained; loose, nonsticky and nonplastic; few soft masses of lime; strong effervescence; strongly alkaline; clear wavy boundary.

IIC4—34 to 60 inches; light yellowish brown (2.5Y 6/3) gravelly sand, light olive brown (2.5Y 5/4) when moist; single grained; loose, nonsticky and nonplastic; strong effervescence; strongly alkaline.

The A horizon is 5 to 14 inches thick and ranges from very dark gray to gray. It has weak to strong effervescence. The Cca horizon has common to many soft masses of lime. Its upper boundary is within 16 inches of the surface. It ranges from gray to white and is mostly loam, but ranges from sandy loam to clay loam. The lower part of the Cca horizon commonly contains faint to distinct yellowish brown mottles. The IIC horizon is mixed very gravelly and gravelly sand, loamy sand, and coarse sand. Depth to the IIC material ranges from 20 to 40 inches.

Divide soils are associated in the landscape with Marysland, Stady, Bowdle, and Hamerly soils. They are better drained than Marysland soils, are not so well drained as Stady and Bowdle soils, and have more sand and gravel in the C horizon than Hamerly soils.

Dv—Divide loam. This is the only Divide soil mapped in the county. It is nearly level. Slopes are 0 to 1 percent. Included with this soil in mapping were a few small areas of Marysland, Bowdle, Ruso, Stady, Manning, and Wabek soils. Also included are a few gently undulating areas.

This soil is somewhat poorly drained and has slow runoff. The water table is within 2 or 3 feet of the surface in spring or during rainy seasons.

This soil is suited to all crops commonly grown in the county. About half the acreage is used for crops. The chief limitation is droughtiness caused by the moderate depth of the root zone over sand and gravel. The main management concerns are controlling soil blowing, conserving moisture, and maintaining fertility and tilth. Timely operations because of wet conditions in spring are also a concern. Capability unit IIIs-4L; Silty range site.

Falkirk Series

The Falkirk series consists of deep, nearly level to gently rolling, well drained soils. These soils formed in a loam melt-water mantle 20 to 40 inches thick over loamy glacial till.

In a representative profile the surface layer is dark grayish brown loam about 7 inches thick. The subsoil is dark grayish brown and grayish brown, very friable and friable loam about 21 inches thick. Below this is 6 inches of grayish brown gravelly loam. The underlying material is light brownish gray and light yellowish brown clay loam.

Permeability is moderate in the subsoil and moderately slow in the underlying material. Available water capacity, organic-matter content, and natural fertility are high.

Most of the acreage is cultivated and used for small grain, corn, and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Falkirk loam, 0 to 3 percent slopes, in a cultivated field 1,250 feet east and 46 feet south of the northwest corner, sec. 11, T. 145 N., R. 82 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many roots; neutral; abrupt smooth boundary.

B21—7 to 14 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; faces of peds coated with very dark brown (10YR 2/2) moist; moderate medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; common fine pores; mildly alkaline; clear wavy boundary.

B22—14 to 23 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10 YR 3/2) when moist; faces of peds coated with very dark brown (10 YR 2/2) moist; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; many very fine pores; patches of clay films on vertical faces of

peds; mildly alkaline; gradual wavy boundary.

B3—23 to 28 inches; grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) when moist; moderate medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; slight effervescence in spots; mildly alkaline; clear wavy boundary.

IIC1—28 to 34 inches; grayish brown (2.5Y 5/2) gravelly loam, dark grayish brown (2.5Y 4/2) when moist; weak coarse prismatic structure; slightly hard, friable, slightly sticky and slightly plastic; few fine roots; few fine pores; approximately 35 percent by volume large pebbles and cobbles; strong effervescence; mildly alkaline; clear wavy boundary.

IIIC2ca—34 to 42 inches; light brownish gray (2.5Y 6/2) light clay loam, grayish brown (2.5Y 4/2) when moist; weak coarse prismatic structure; hard, friable, sticky and slightly plastic; few fine roots; few fine pores; common soft masses of segregated lime; strong effervescence; moderately alkaline; diffuse boundary.

IIIC3—42 to 60 inches; light yellowish brown (2.5Y 6/3) light clay loam, light olive brown (2.5Y 5/3) when moist; massive; hard, firm, sticky and slightly plastic; few fine pores; few soft masses of segregated lime; strong effervescence; moderately alkaline.

The A horizon is 6 to 10 inches thick and is very dark grayish brown to grayish brown. It is typically loam but ranges from silt loam to fine sandy loam.

The B horizon is 10 to 24 inches thick and is dark grayish brown to grayish brown. In some pedons there is a ½- to 6-inch gravelly contact line directly above the glacial till. In other pedons a 2- to 10-inch layer of fine sandy loam is above the glacial till.

The IIIC horizon has few to many threads and soft masses of lime. It is multicolored glacial till of clay loam or heavy loam textures. Most pedons have 26 to 36 inches of nearly gravel-free material overlying the glacial till. The mantle has a maximum range of 20 to 40 inches in thickness.

Falkirk soils are associated in the landscape with Bowbells, Roseglen, Williams, and Wilton soils. They contain less clay accumulation in the B2 horizon than Bowbells and Williams soils, are better drained than Roseglen soils, and have less silt in the B horizon than Wilton soils.

FaA—Falkirk loam, 1 to 3 percent slopes. This nearly level and level soil is on broad uplands. Areas are 10 to more than 500 acres in size. This soil has the profile described as representative of the series. Included in mapping were small areas of Arnegard, Williams, Bowbells, Flaxton, Roseglen, and Tonka soils.

This soil is well drained but has slow runoff. It is slightly susceptible to erosion.

This soil is suited to all crops commonly grown in the county. Nearly all the acreage is used for crops. A few areas remain in native range. The chief management needs are conserving moisture and maintaining fertility and tilth. Capability unit IIc–6; Silty range site.

FaB—Falkirk loam, 3 to 6 percent slopes. This gently sloping soil is on smooth uplands. Areas are 10 to more than 200 acres in size. This soil has a profile similar to the one described as representative of the series, but it has a slightly thinner surface layer and subsoil. Included in mapping were small areas of Arnegard, Williams, Bowbells, Flaxton, Roseglen, and Tonka soils.

This soil is well drained but has slow runoff. It is slightly susceptible to erosion.

This soil is suited to all crops commonly grown in the county. Nearly all the acreage is used for crops. A few areas remain in native range. The main management needs are conserving moisture and maintaining fertility and tilth. Capability unit IIe–6; Silty range site.

FbA—Falkirk and Max loams, 1 to 3 percent slopes. This nearly level mapping unit is on smooth, broad terraces in uplands. The underlying glacial till has been mantled with varying thickness of loam textured alluvium. About 50 percent of the total acreage is Falkirk loam, 20 percent is Max loam, 15 percent is Bowdle loam, and 15 percent is minor soils. The profiles of the major soils are similar to the ones described for the respective series, but the Falkirk soil has slightly thinner darkened upper layers. Included in mapping were small areas of Arnegard, Bowbells, Stady, Williams, Roseglen, Tansem, Tonka, and Parnell soils.

This unit is well drained but has slow runoff. It is only slightly susceptible to erosion. It is suited to all crops commonly grown in the county. Most of the acreage is used for crops. The main management needs are conserving moisture and maintaining fertility and tilth. Capability unit IIc–6; Silty range site.

FbB—Falkirk and Max loams, 3 to 6 percent slopes. This gently sloping mapping unit is on terraces and uplands. The underlying glacial till has been mantled with varying thickness of loam textured alluvium. About 50 percent of the total acreage is Falkirk loam, 20 percent is Max loam, 15 percent is Bowdle and Stady loams, and 15 percent is minor soils. The profiles of the major soils are similar to those described for the respective series, but the Falkirk soil has slightly thinner darkened upper layers. Included with these soils in mapping were small areas of Arnegard, Bowbells, Tonka, Williams, Roseglen, Tansem, and Parnell soils.

This unit is well drained and has slow to medium runoff. It is slightly susceptible to erosion. It is suited to all the crops commonly grown in the county. Most of the acreage is used for crops. The rest is in native range or pasture. The main management needs are controlling erosion, conserving moisture, and maintaining fertility and tilth. Capability unit IIe–6; Silty range site.

FbC—Falkirk and Max loams, 6 to 9 percent slopes. This gently rolling mapping unit is on terraces and uplands. The underlying glacial till has been mantled with varying thickness of loam textured alluvium. About 50 percent of the total acreage is Falkirk loam, 20 percent is Max loam, 15 percent is Stady and

Bowdle loams, and 15 percent is minor soils. The profiles of these soils are similar to those described for the respective series, but the Falkirk soil has a thinner surface layer and subsoil. Included in mapping were small areas of Arnegard, Bowbells, Tansem, Williams, Roseglen, Tonka, and Parshall soils.

This unit is well drained and has medium runoff. It is subject to moderate erosion. It is suited to all crops commonly grown in the county. Most of the acreage is used for crops. The rest is in native range or pasture. The main management needs are controlling erosion, conserving moisture, and maintaining fertility and tilth. Capability unit IIIe-6; Silty range site.

Farnuf Series

The Farnuf series consists of deep, nearly level and gently sloping, well drained loams on terraces, fans, and outwash plains. These soils formed in alluvium.

In a representative profile the surface layer is dark grayish brown loam about 3 inches thick. The subsoil is dark grayish brown and grayish brown friable clay loam about 11 inches thick. The underlying material is light brownish gray and olive clay loam and loam.

Permeability and organic-matter content are moderate. Available water capacity and natural fertility are high.

These soils are used for crops and range. The native vegetation is mid and short prairie grasses.

Representative profile of Farnuf loam, 3 to 6 percent slopes, in pasture 1,600 feet south and 1,180 feet west of the northeast corner, sec. 33, T. 149 N., R. 85 W.

A1—0 to 3 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; neutral; gradual boundary.

B1—3 to 7 inches; dark grayish brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) when moist; moderate medium prismatic structure parting to weak medium subangular blocky; slightly hard, friable, sticky and plastic; many fine pores; neutral; clear boundary.

B2t—7 to 14 inches; grayish brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) when moist; ped faces coated with very dark brown (10YR 2/2) when moist; strong medium prismatic structure parting to strong fine subangular blocky; hard, friable, sticky and plastic; many fine pores; continuous clay films; neutral; clear boundary.

C1—14 to 24 inches; light brownish gray (2.5Y 6/2) light clay loam, dark grayish brown (2.5Y 4/2) when moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, firm, sticky and plastic; common fine pores; few soft masses of lime; strong effervescence; mildly alkaline; gradual boundary.

C1ca—24 to 36 inches; light brownish gray (2.5Y 6/2) light clay loam, dark grayish brown (2.5Y 4/2) when moist; massive; hard, firm, sticky and plastic; few fine pores; common soft masses of lime; strong effervescence; moderately alkaline; gradual boundary.

C3—36 to 60 inches; olive (5Y 5/3) loam (5Y 4/3) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; strong effervescence; strongly alkaline.

Farnuf soils are associated in the landscape with Rhoades, Straw, and Williams soils. In contrast with Rhoades soils, they do not have a high sodium content. They have a larger clay accumulation in the B2 horizon than Straw soils and are more stratified in the C horizon than Williams soils.

FfA—Farnuf loam, 1 to 3 percent slopes. This nearly level soil is on terraces, fans, and outwash plains. Included in mapping were small areas of Arnegard, Grail, Stady, and Williams soils. Also included were a few areas of Rhoades soils, which are identified by spot symbols on the soil map.

This soil is well drained and has medium runoff. It is slightly susceptible to erosion. Natural fertility is high.

This soil is suited to all crops commonly grown in the county and is also suited to irrigated crops. More than half the acreage is cultivated. The rest is in native range. The chief management needs are conserving moisture and maintaining fertility and tilth. Capability unit IIc-6; Silty range site.

FfB—Farnuf loam, 3 to 6 percent slopes. This gently sloping soil is on terraces, fans, and outwash plains. It has the profile described as representative of the series. Included in mapping were small areas of Arnegard, Grail, Stady, and Williams soils. Also included were a few areas of Rhoades soils that are indicated by spot symbols on the soil map.

This soil is well drained and has medium runoff. It is slightly susceptible to erosion.

This soil is suited to all crops commonly grown in the county and is also suited to irrigated crops. More than half the acreage is used for crops. The rest is in native range. The chief management needs are controlling erosion, conserving moisture, and maintaining fertility and tilth. Capability unit IIe-6; Silty range site.

Flasher Series

The Flasher series consists of shallow, moderately sloping to very steep, somewhat excessively drained fine sandy loams on crests of hills, ridges, and valleysides. These soils formed in material weathered from sandstone.

In a representative profile the surface layer is grayish brown fine sandy loam about 5 inches thick. The underlying material is very friable grayish brown and light yellowish brown loamy fine sand. Sandstone is at 17 inches.

Permeability is moderately rapid. Available water capacity is very low. The organic-matter content and natural fertility are low.

These soils are used mostly for range and pasture.

Representative profile of Flasher fine sandy loam, 6 to 15 percent slopes, in rangeland 980 feet south and 40 feet west of the northeast corner, sec. 31, T. 149 N., R. 89 W.

A1—0 to 5 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; slight effervescence; neutral; clear boundary.

AC—5 to 9 inches; grayish brown (2.5Y 5/2) loamy fine sand, very dark grayish brown (2.5Y 4/2) when moist; weak coarse subangular blocky structure parting to weak fine granular; slightly hard, very friable, nonsticky and nonplastic; strong effervescence; mildly alkaline; gradual boundary.

C1—9 to 17 inches; light yellowish brown (2.5Y 6/4) loamy fine sand, light olive brown (2.5Y 5/4) when moist; massive; slightly hard, very friable, nonsticky and nonplastic; strong effervescence; mildly alkaline; gradual boundary.

C2—17 to 60 inches; light yellowish brown (2.5Y 6/4) soft sandstone, light olive brown (2.5Y 5/4) when moist; weak platy; hard, firm, nonsticky and nonplastic; strong effervescence; mildly alkaline.

The A horizon is dark grayish brown or grayish brown loamy fine sand, fine sandy loam, or sandy loam. The C horizon is loamy sand or loamy fine sand. A few films and threads of segregated lime occur in the C horizon and upper part of the soft sandstone. The soft sandstone begins at 10 to 20 inches. It crushes easily to fine sand or loamy fine sand.

Flasher soils are associated in the landscape with Cohagen and Vebar soils. They contain more sand than Cohagen soils and are less deep than Vebar soils.

FlD—Flasher fine sandy loam, 6 to 15 percent slopes. This moderately sloping and strongly sloping soil is on ridges and valleysides. It has the profile described as representative of the series. Included in mapping were small areas of Cabba, Vebar, Parshall, Lihen, and Cohagen soils.

This soil is somewhat excessively drained and has medium runoff. It is highly susceptible to erosion.

Nearly all the acreage is in range and pasture. A few areas are cropped and should be seeded to grass. Management is needed to maintain good stands of native grass. Capability unit VIe–Sw; Shallow range site.

FlE—Flasher fine sandy loam, 15 to 35 percent slopes. This moderately steep to very steep soil is on ridges and valleysides. Included in mapping were small areas of Cabba, Vebar, Parshall, Lihen, and Cohagen soils.

This soil is somewhat excessively drained and has medium runoff. It is highly susceptible to erosion.

Nearly all the acreage is in range and pasture. Management is needed to maintain good stands of native grass. Capability unit VIe–Sw; Shallow range site.

Flaxton Series

The Flaxton series consists of deep, nearly level to moderately sloping, well drained soils. These soils formed in a sandy loam mantle over glacial till.

In a representative profile the surface layer is dark grayish brown fine sandy loam about 10 inches thick. The subsoil, about 25 inches thick, is very friable, brown fine sandy loam in the upper 21 inches and friable, grayish brown clay loam in the lower 4 inches. The underlying material is light brownish gray clay loam.

Permeability is moderately rapid in the upper subsoil and moderately slow in the underlying material. Available water capacity and organic-matter content are high. Natural fertility is medium.

Nearly all the acreage is used for crops. The native vegetation is mid and short prairie grasses.

Representative profile of Flaxton fine sandy loam, 1 to 3 percent slopes, 2,400 feet east and 150 feet north of southwest corner sec. 35, T. 145 N., R. 83 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) when moist; moderate medium granular structure; slightly hard, very friable, nonsticky and nonplastic; slightly acid; abrupt boundary.

A12—6 to 10 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) when moist; weak medium prismatic structure; slightly hard, very friable, nonsticky and nonplastic; neutral; clear boundary.

B21—10 to 24 inches; brown (10YR 5/3) fine sandy loam, dark brown (10YR 3/3) when moist; weak medium prismatic structure; slightly hard, very friable, nonsticky and nonplastic; neutral; clear boundary.

B22—24 to 31 inches; brown (10YR 5/3) fine sandy loam, brown to dark brown (10YR 4/3) when moist; weak medium prismatic structure; slightly hard, very friable, nonsticky and nonplastic; neutral; abrupt boundary.

IIB23t—31 to 35 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; strong medium prismatic structure parting to moderate medium angular blocky; hard, friable, sticky and plastic; clay films on vertical faces; tongues of sandy material between peds; few pebbles and shale fragments; neutral; clear irregular boundary.

IIC1ca—35 to 42 inches; light brownish gray (2.5Y 6/2) clay loam, light olive brown (2.5Y 5/3) when moist; few fine distinct brownish yellow (10YR 6/6) mottles; massive; hard, firm, sticky and plastic; common threads and masses of lime; few pebbles and shale fragments; strong effervescence; moderately alkaline; clear irregular boundary.

IIC2—42 to 60 inches; light brownish gray (2.5Y

6/2) clay loam, light olive brown (2.5Y 5/3) when moist; few fine distinct brownish yellow (10YR 6/6) mottles; massive; hard, firm, sticky and plastic; few threads and masses of lime; few pebbles and shale fragments; strong effervescence; moderately alkaline.

The A horizon and part of the B horizon formed in fine sandy loam sediment. The IIB and IIC horizons formed in glacial till. The A horizon is fine sandy loam or loam. The IIB and IIC horizons begin between depths of 20 and 40 inches.

Flaxton soils are associated in the landscape with Krem, Parshall, and Williams soils. In the upper B2 horizon, Flaxton soils have less sand than Krem soils and more sand than Williams soils. They have more clay accumulation in the B2 horizon than Parshall soils.

FnA—Flaxton fine sandy loam, 1 to 3 percent slopes. This nearly level soil is on glacial till uplands mantled by fine sandy loams. It has the profile described as representative of the series. Included in mapping were small areas of Zahl, Williams, Krem, and Parshall soils.

This soil is well drained but has slow runoff. It is moderately susceptible to erosion.

This soil is suited to all crops commonly grown in the county. Most of the acreage is used for crops. The rest is in native range or pasture. The chief management needs are conserving moisture, controlling soil blowing, and maintaining fertility and tilth. Capability unit IIIe-3; Sandy range site.

FnB—Flaxton fine sandy loam, 3 to 6 percent slopes. This gently sloping soil is on glacial till plains mantled by fine sandy loams. Included in mapping were small areas of Zahl, Williams, Krem, and Parshall soils.

This soil is well drained but has slow runoff. It is moderately susceptible to erosion.

This soil is suited to all crops commonly grown in the county. Nearly all the acreage is used for crops. The rest is in native range or pasture. The main management needs are controlling erosion, conserving moisture, and maintaining fertility and tilth. Capability unit IIIe-3; Sandy range site.

FnC—Flaxton fine sandy loam, 6 to 9 percent slopes. This moderately sloping soil is on glacial till uplands mantled by fine sandy loams. It has a slightly thinner surface layer than that described as representative of the series. Included in mapping were small areas of Zahl, Williams, Krem, and Parshall soils.

This soil is well drained but has slow runoff. It is severely susceptible to erosion.

Most of the soil is in crops. The rest is in native range or pasture. The main management concern is controlling erosion. Other needs are conserving moisture and maintaining fertility and tilth. Capability unit IVe-3; Sandy range site.

Fossum Series

The Fossum series consists of deep, level, poorly drained fine sandy loams in drainageways. These soils formed in deep sandy material.

In a representative profile the surface layer is dark gray fine sandy loam and loam about 6 inches thick. The subsurface layer is mottled dark gray and dark grayish brown loamy fine sand. The underlying material is light olive brown and gray fine sand and sandy loam.

Permeability is moderately rapid in the surface layer and rapid in the underlying layer. Available water capacity is low. Organic-matter content is high. Natural fertility is medium.

Nearly all the acreage is in native vegetation and is used for range or hay.

Representative profile of Fossum fine sandy loam in range 200 feet north and 1,600 feet west of southeast corner sec. 18, T. 145 N., R. 83 W.

Ap—0 to 5 inches; dark gray (10YR 4/1) fine sandy loam, black (10YR 2/1) when moist; common medium distinct dark brown (10 YR 3/3) mottles; weak fine crumb structure; soft, very friable, nonsticky and nonplastic; slight effervescence; neutral; clear boundary.

A12—5 to 6 inches; dark gray (10YR 4/1) loam, black (N/2) when moist; weak fine crumb structure; soft, very friable, slightly sticky and slightly plastic; slight effervescence; neutral; clear boundary.

A13—6 to 13 inches; dark gray (10YR 4/1) loamy fine sand, very dark brown (10YR 2/2) when moist; few fine faint light olive brown (2.5Y 5/4) mottles; weak coarse blocky structure; loose, very friable, nonsticky and nonplastic; slight effervescence; neutral; gradual boundary.

A14—13 to 18 inches; dark grayish brown (2.5Y 4/2) loamy fine sand, very dark grayish brown (2.5Y 3/2) when moist; common medium distinct light olive brown (2.5Y 5/4) mottles; weak coarse blocky structure; loose, very friable, nonsticky and nonplastic; slight effervescence; mildly alkaline; gradual boundary.

C1g—18 to 23 inches; light olive brown (2.5Y 5/4) fine sand, olive brown (2.5Y 4/3) when moist; common medium distinct dark gray (5Y 4/1) mottles; single grained; loose, nonsticky and nonplastic; slight effervescence; mildly alkaline; clear boundary.

C2g—23 to 50 inches; light olive brown (2.5Y 5/6) fine sand, olive brown (2.5Y 4/3) when moist; common medium distinct dark gray (5Y 4/1) mottles; single grained; loose, nonsticky and nonplastic; strong effervescence; mildly alkaline; gradual boundary.

C3g—50 to 60 inches; gray (5Y 5/1) sandy loam, dark gray (5Y 4/1) when moist; single grained; hard, very friable, nonsticky and nonplastic; strong effervescence; mildly alkaline.

The A horizon is 15 to 24 inches thick. It is dominantly fine sandy loam, but the range includes loam and loamy sand. Mottles range from few to common and fine to medium in the lower A horizon. The C horizon ranges from loamy fine sand to sand and com-

monly has a few thin strata of finer textured material. The soil is limy throughout and has very slight to strong effervescence. In places, it is slightly or moderately saline.

Fossum soils are associated in the landscape with the better drained Lihen soils.

Fs—Fossum fine sandy loam. This soil is in concave areas in sandy outwash plains. It is the only Fossum soil mapped in the county. Slopes are 0 to 1 percent. Included in mapping were small areas of Marysland, Lihen, and Colvin soils.

This soil is poorly drained and has very slow runoff. Soil blowing is a hazard if the native vegetation is removed.

This soil is suited to crops if excess water is removed. Nearly all the acreage is used for range. In cultivated areas, the main management needs are controlling water, controlling erosion, and maintaining fertility and tilth. Capability unit IIIw–3; Wet Meadow range site.

Grail Series

The Grail series consists of deep, nearly level and gently sloping, well drained silty clay loams in broad swales, on smooth terraces, and on foot slopes. These soils formed in alluvium.

In a representative profile the surface layer is dark grayish brown silty clay loam about 11 inches thick. The firm subsoil is grayish brown silty clay about 9 inches thick. The underlying material is light brownish gray, light gray, and dark gray silty clay loam, clay loam, and loam.

Permeability is moderately slow. Available water capacity, organic-matter content, and natural fertility are high.

These soils are in crops and range. The native vegetation is mid and short prairie grasses.

Representative profile of Grail silty clay loam, 1 to 3 percent slopes, in cultivated field 200 feet west and 200 feet south of northeast corner sec. 33, T. 149 N., R. 86 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; moderate medium granular structure; hard, firm, sticky and slightly plastic; mildly alkaline; abrupt smooth boundary.

A12—6 to 11 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; weak medium subangular blocky structure parting to moderate medium granular; hard, firm, sticky and slightly plastic; neutral; clear wavy boundary.

B2t—11 to 20 inches; grayish brown (10YR 5/2) silty clay, very dark grayish brown (10YR 3/2) when moist; moderate medium prismatic structure parting to moderate fine subangular blocky; hard, firm, sticky and slightly plastic; thin clay films on ped faces; mildly alkaline; clear wavy boundary.

C1ca—20 to 27 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; weak coarse prismatic structure parting to weak fine subangular blocky; hard, firm, sticky and slightly plastic; few soft masses of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C2ca—27 to 44 inches; light gray (2.5Y 7/2) silty clay loam, grayish brown (2.5Y 5/2) when moist; massive; hard, firm, sticky and slightly plastic; common soft masses of lime; strong effervescence; moderately alkaline; abrupt wavy boundary.

IIA1b—44 to 55 inches; dark gray (10YR 4/1) clay loam, black (10YR 2/1) when moist; massive; hard, friable, sticky and plastic; slight effervescence; moderately alkaline; clear wavy boundary.

IICca—50 to 60 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) when moist; few medium distinct gray (5Y 5/1) and few medium distinct strong brown (7.5Y 5/6) mottles; massive; hard, firm, slightly sticky and slightly plastic; few soft masses of lime; strong effervescence; moderately alkaline.

The A horizon is 7 to 24 inches thick and ranges from dark gray to grayish brown. The texture is typically silty clay loam, but in some places it is silt loam or clay loam.

The B2 horizon is heavy silty clay loam or silty clay with 35 to 45 percent clay. The depth to calcareous material ranges from 18 to more than 40 inches.

The C horizon has slight to strong effervescence. The texture ranges from loam to clay but is dominantly silty clay loam.

Grail soils are associated in the landscape with Regent and Morton soils but are deeper.

GaA—Grail silty clay loam, 1 to 3 percent slopes. This nearly level soil is in drainageways and swales. It has the profile described as representative of the series. Included in mapping were areas of Arnegard, Parnell, Tonka, and Bowbells soils. Also included were a few small areas of Rhoades soils, which were identified by spot symbols.

This soil is well drained and has medium runoff. It is slightly susceptible to erosion.

This soil is suited to all crops commonly grown in the county. Nearly all the acreage is used for crops. The chief management needs are conserving moisture and maintaining fertility and tilth. Capability unit IIc–7; Overflow range site.

GaB—Grail silty clay loam, 3 to 6 percent slopes. This gently sloping soil is in drainageways and swales and on foot slopes. Included in mapping were small areas of Arnegard, Parnell, Tonka, and Bowbells soils. Also included were a few small areas of Rhoades soils, which were indicated by spot symbols.

This soil is well drained and has medium runoff. It is slightly susceptible to erosion.

This soil is suited to all crops commonly grown in the county. Nearly all the acreage is used for crops. The chief management needs are conserving moisture

and maintaining fertility and tilth. Capability unit IIe–7; Silty range site.

Grano Series

The Grano series consists of deep, level, very poorly drained silty clay soils in low flat basins and in depressions on lake plains. These soils formed in alluvium.

In a representative profile the surface layer is dark gray and gray silty clay about 17 inches thick. The underlying material is light gray, gray, and white silty clay and clay loam.

Permeability is slow. Available water capacity and organic-matter content are high. Natural fertility is medium.

Nearly all the acreage is in native pasture. The native vegetation is mid and tall prairie grasses and some aquatic plants.

Representative profile of Grano silty clay in pasture 2,300 feet north and 2,100 feet east of southwest corner sec. 22, T. 145 N., R. 82 W.

O1—3 inches to 0; organic mat of roots.

A11—0 to 3 inches; dark gray (2.5Y 4/1) silty clay, black (2.5Y 2/1) when moist; moderate fine crumb structure; very friable, sticky and plastic; mildly alkaline; clear wavy boundary.

A12—3 to 9 inches; dark gray (2.5Y 4/1) silty clay, black (2.5Y 2/1) when moist; strong fine angular blocky structure; friable, sticky and plastic; slight effervescence; mildly alkaline; gradual wavy boundary.

A13g—9 to 17 inches; gray (5Y 5/1) silty clay, black (5Y 2/1) when moist; strong fine angular blocky structure; firm, sticky and plastic; strong effervescence; mildly alkaline; gradual irregular boundary.

C1g—17 to 28 inches; light gray (5Y 7/1) and gray (5Y 5/1) silty clay, gray (5Y 5/1) and very dark gray (5Y 3/1) when moist; weak fine angular blocky structure; firm, sticky and plastic; strong effervescence; moderately alkaline; gradual boundary.

C2g—28 to 48 inches; gray and light gray (5Y 6/1) silty clay, dark gray (5Y 4/1) when moist; massive; firm, sticky and plastic; strong effervescence; strongly alkaline; clear boundary.

C3g—48 to 60 inches; white (5Y 8/1) clay loam, light gray (5Y 7/2) when moist; massive; firm, sticky and plastic; common snail shells; violent effervescence; moderately alkaline.

The A horizon has hue of 5Y or 2.5Y. The texture is silty clay or silty clay loam. In some pedons, a horizon of lime accumulation occurs below 16 inches. The texture of the C horizon is silty clay or clay. Coarser textured material occurs below 40 inches in some pedons.

Grano soils are associated in the landscape with Dimmick, Sinai, and Nutley soils. They have more lime than Dimmick soils and are not so well drained as Sinai and Nutley soils.

Gn—Grano silty clay. This level soil is in broad flat basins. It is the only Grano soil mapped in the county. Slopes are 0 to 1 percent. Included in mapping were areas of Parnell, Dimmick, Marysland, and Hamerly soils.

This soil is very poorly drained. Runoff ponds. The water table is at or near the surface in spring and after heavy rains. Permeability is slow.

Nearly all the acreage is used for pasture. It needs to be drained of excess water before it can be successfully cultivated. An important management need is maintaining fertility and tilth. Capability unit IIIw–4L; Wetland range site.

Grassna Series

The Grassna series consists of deep, nearly level, well drained silt loams in swales and broad, slightly concave areas. These soils formed in deep silt loam loess or alluvium from loess.

In a representative profile the surface layer is dark grayish brown silt loam about 17 inches thick. The very friable subsoil is grayish brown silt loam about 22 inches thick. The underlying material is light brownish gray silt loam and loam.

Permeability is moderate. Available water capacity, organic-matter content, and natural fertility are high.

Nearly all the acreage is in crops. The native vegetation is mid and short prairie grasses.

Representative profile of Grassna silt loam, 1 to 3 percent slopes, in cultivated field 1,400 feet south and 60 feet east of northwest corner sec. 17, T. 144 N., R. 83 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; neutral; abrupt boundary.

A12—8 to 17 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; weak medium and coarse prismatic structure parting to weak coarse blocky; hard, very friable, slightly sticky and slightly plastic; common medium pores; neutral; clear wavy boundary.

B2—17 to 34 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate medium prismatic structure parting to moderate medium blocky; slightly hard, very friable, slightly sticky and slightly plastic; many fine pores; a few patches of clay films on vertical faces; neutral; clear wavy boundary.

B3 –34 to 39 inches; grayish brown (2.5Y 5/2) silt loam, very dark grayish brown (2.5Y 3/2) when moist; moderate medium prismatic structure parting to weak medium blocky; slightly hard, very friable, slightly sticky and slightly plastic; com-

mon fine pores; slight effervescence in places; mildly alkaline; gradual wavy boundary.

C1ca—39 to 50 inches; light brownish gray (2.5Y 6/2) silt loam, olive brown (2.5Y 4/3) when moist; weak coarse prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; many threads and soft masses of lime; strong effervescence; mildly alkaline; clear boundary.

IIC2—50 to 60 inches; light brownish gray (2.5Y 6/2) heavy loam, olive brown (2.5Y 4/3) when moist; massive; slightly hard, friable, slightly sticky and slightly plastic; few pebbles; few threads and films of lime; strong effervescence; mildly alkaline.

The A horizon is 10 to 20 inches thick and is very dark grayish brown or dark grayish brown. The B2 horizon, which is 12 to 30 inches thick, is dark grayish brown or grayish brown. The texture is silt loam or light silty clay loam. The C horizon has a few to many threads and soft masses of lime. It is mostly silt loam, but strata of coarser and finer textures occur below 40 inches in places. Depth to carbonates ranges from 20 to more than 40 inches.

Grassna soils are associated in the landscape with Linton, Wilton, Mandan, and Temvik soils. They have more clay in the B2 horizon than Linton and Mandan soils. They differ from Wilton and Temvik soils in not having glacial till within 40 inches of the surface.

GoA—Grassna silt loam, 1 to 3 percent slopes. This nearly level soil is the only Grassna soil mapped in the county. It is in smooth, slightly concave, broad swales. Included in mapping were small areas of Arnegard, Wilton, Mandan, and Temvik soils.

This soil is well drained but has slow runoff. It is suited to all crops commonly grown in the county. Nearly all the acreage is cropped. Only a few areas are in native range. The main management needs are conserving moisture and maintaining fertility and tilth. Capability unit IIc–6; Overflow range site.

Hamerly Series

The Hamerly series consists of deep, nearly level, somewhat poorly drained loams that are limy at or near the surface. These soils occur as rings and irregularly shaped areas surrounding depressions. They formed in calcareous loamy glacial till.

In a representative profile the surface layer is dark gray loam about 6 inches thick. The underlying material is a light gray and grayish brown loam and clay loam.

Permeability is moderately slow. Available water capacity and natural fertility are high. Organic-matter content is medium. A seasonal water table rises to within 2 to 5 feet of the surface during wet periods.

Nearly all the acreage is cultivated and used for small grain, corn, and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Hamerly loam, 1 to 3 percent slopes, in cultivated field 2,500 feet east and 210 feet north of southwest corner sec. 23, T. 149 N., R. 87 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) loam, very dark gray (10YR 3/1) when moist; moderate medium crumb structure; slightly hard, friable, slightly sticky and slightly plastic; few fine pebbles; slight effervescence; neutral; abrupt smooth boundary.

Cca—6 to 27 inches; light gray (2.5Y 7/2) loam, light brownish gray (2.5Y 6/2) when moist; very few olive mottles; weak coarse prismatic structure parting to moderate medium subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few fine pebbles; many soft masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C1—27 to 35 inches; grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) when moist; few fine faint gray (5Y 5/1) mottles; massive; slightly hard, friable, slightly sticky and slightly plastic; few fine pebbles; slight effervescence; moderately alkaline; gradual wavy boundary.

C2—35 to 60 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; common fine faint gray (5Y 5/1) and common medium distinct olive (5Y 4/5) mottles; massive; hard, firm, slightly sticky and slightly plastic; common fine pebbles; slight effervescence; moderately alkaline.

The A horizon is 6 to 15 inches thick and is dark gray to grayish brown. It is clay loam in some places. The Cca horizon has lime disseminated through the mass or segregated in films and masses. Mottles are common in the underlying material below about 20 inches. In some places there is a layer that contains gypsum crystals.

Hamerly soils are associated in the landscape with Williams, Parnell, Tonka, and Colvin soils. They are not so well drained as Williams soils but are better drained than Parnell, Tonka, and Colvin soils.

HaA—Hamerly loam, 1 to 3 percent slopes. This nearly level soil is on glacial till uplands and occurs as irregular rings adjacent to enclosed depressions. It is the only Hamerly soil mapped in the county. Included in mapping were small areas of Tonka, Parnell, Colvin, Bowbells, and Williams soils. Also included were some gently sloping soils.

This soil is moderately well drained and has medium runoff. It is slightly susceptible to erosion.

Nearly all the acreage is used for crops. The rest is in native range or pasture. The soil is suited to all crops commonly grown in the county. It is wet many times in the spring and must be seeded late. The chief management needs are controlling soil blowing, conserving moisture, and maintaining fertility and tilth. Capability unit IIes–4L; Silty range site.

Harriet Series

The Harriet series consists of deep, level, poorly

drained soils. These soils formed in stratified calcareous loamy alluvium.

In a representative profile the surface layer is gray very fine sandy loam about 2 inches thick. The firm subsoil, about 9 inches thick, is dark gray clay in the upper 2 inches and grayish brown clay loam in the lower 7 inches. The underlying material is grayish brown, light olive brown, and light brownish gray clay loam, fine sandy loam, and silty clay.

Permeability is slow. Available water capacity and natural fertility are low. Organic-matter content is moderate.

Most of the acreage is used for native range or pasture. The native vegetation is inland saltgrass, alkali sacaton, Nuttall alkaligrass, and other salt-tolerant grasses.

Representative profile of Harriet very fine sandy loam in grassy area of Harriet-Saline land complex 300 feet east and 75 feet north of southwest corner sec. 36, T. 144 N., R. 81 W.

A2—0 to 2 inches; gray (10YR 5/1) very fine sandy loam, very dark gray (10YR 3/1) when moist; weak medium and thin platy structure, slightly hard, very friable, nonsticky and nonplastic; many fine roots; neutral; abrupt boundary.

B21t—2 to 4 inches; dark gray (2.5Y 4/1) clay, black (2.5Y 2/1) when moist; strong medium and fine columnar structure parting to moderate medium subangular blocky; very hard, firm, sticky and plastic; common fine roots; many fine pores; patches of clay films; moderately alkaline; clear boundary.

B22t—4 to 11 inches; grayish brown (2.5Y 3/2) clay loam, very dark grayish brown (2.5Y 3/2) when moist; moderate medium prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky and plastic; common fine roots; many fine pores; patches of clay films; few nests of salts; few threads of lime; strong effervescence; strongly alkaline; gradual boundary.

C1—11 to 18 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; weak coarse prismatic structure; very hard, firm, sticky and plastic; few roots; few nests of salt crystals; strong effervescence; very strongly alkaline; clear boundary.

C2—18 to 30 inches; light olive brown (2.5Y 5/3) clay loam, olive brown (2.5Y 4/3) when moist; massive; very hard, firm, sticky and plastic; very few roots; few nests of salt crystals; strong effervescence; very strongly alkaline; clear boundary.

C3—30 to 42 inches; light olive brown (2.5Y 5/3) fine sandy loam, olive brown (2.5Y 4/3) when moist; few fine distinct gray (5Y 5/1) mottles; friable, slightly sticky and nonplastic; strong effervescence; very strongly alkaline; clear boundary.

C4—42 to 60 inches; light brownish gray (2.5Y 6/2) silty clay, grayish brown (2.5Y 5/2) when moist; massive; very hard, firm, sticky and plastic; few nests of salt crystals; strong effervescence; strongly alkaline.

The A2 horizon is dominantly loam, but ranges from silt loam to very fine sandy loam. It is 1 to 4 inches thick and is gray or light gray. Some pedons have a 1- to 2-inch A1 horizon overlying the A2 horizon.

The B2t horizon is 7 to 18 inches thick. It is clay loam or clay that is 35 to 45 percent clay. Threads and nests of salt crystals range from few to many.

The C horizon is gray to light olive brown. It ranges from fine sandy loam to clay and is commonly stratified.

Depth to lime ranges from 2 to 10 inches. The water table is at or near the surface in spring, but is deeper than 3 feet in fall.

Harriet soils are associated in the landscape with Rhoades soils. They are not so well drained as Rhoades soils.

Hk—Harriet-Saline land complex. This mapping unit is in channels and on low terraces, foot slopes, and bottom land along upland streams. It is dominantly nearly level. A few small areas are gently sloping. Slopes are 0 to 1 percent. About 50 percent is Harriet very fine sandy loam and 50 percent is Saline land. Saline land has such a high concentration of soluble salts that only the most persistent salt-tolerant plants can grow. The texture ranges from loamy fine sand to clay. Included in mapping were small areas of Rhoades, Colvin, Straw, and Havrelon soils.

This unit is poorly drained. The seasonal high water table is within 1 foot of the surface for a short time in spring. Runoff is very slow. In many areas a salt crust commonly appears on the surface during dry periods.

Nearly all the acreage is in native vegetation and is used for range. A few areas have been cultivated and abandoned. Management is needed to maintain good stands of native grass. Capability unit VIw–SL; Harriet soils in Saline Lowland range site; Saline land not assigned to a range site.

Havrelon Series

The Havrelon series consists of deep, level, well drained soils on bottom land and low terraces. These soils formed in stratified beds of loamy alluvium.

In a representative profile the surface layer is light brownish gray very fine sandy loam about 6 inches thick. The underlying material is light brownish gray and grayish brown loam, silty clay loam, silty clay, and fine sandy loam.

Permeability is moderate. Available water capacity is high. Natural fertility is medium. Organic-matter content is low.

Nearly all the acreage is cultivated and used for small grain, corn, and alfalfa. The native vegetation is mixed grasses, shrubs, and trees.

Representative profile of Havrelon very fine sandy loam in cropland about 300 feet from riverbank 4,600 feet south and 200 feet east of northwest corner sec. 29, T. 144 N., R. 83 W.

Ap—0 to 6 inches; light brownish gray (2.5Y

6/2) very fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; strong effervescence; neutral; abrupt boundary.

C1—6 to 18 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) when moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; strong effervescence; neutral; abrupt boundary.

C2—18 to 26 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; massive; slightly plastic; two ½-inch strata of loam; strong effervescence; neutral; abrupt boundary.

C3—26 to 29 inches; grayish brown (2.5Y 5/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; strong fine angular blocky structure; hard, firm, sticky and plastic; strong effervescence; neutral; abrupt boundary.

C4—29 to 36 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) when moist; weak bedding planes; slightly hard, very friable, slightly sticky and slightly plastic; strong effervescence; mildly alkaline; clear boundary.

C5—36 to 60 inches; light brownish gray (2.5Y 6/2) fine sandy loam; weak bedding planes; soft, very friable, nonsticky and nonplastic; few strata of loam; strong effervescence; mildly alkaline.

The A horizon is 2 to 8 inches thick and is grayish brown or light brownish gray. The texture is dominantly very fine sandy loam or silty clay, but it ranges to loam. The C horizon ranges from grayish brown to pale yellow. These horizons are mainly loam, but strata ranging from silty clay to loamy fine sand are common. The soil is typically calcareous throughout, but the upper 3 to 6 inches is noncalcareous in some profiles. In places salinity is slight to moderate. Yellowish brown mottles occur in the lower C horizon in places.

Havrelon soils are associated in the landscape with Banks, Trembles, and Lohler soils. They have more clay than Banks and Trembles soils and less clay than Lohler soils.

Hn—Havrelon very fine sandy loam. This level soil is on low terraces and bottom land. Slopes are 0 to 1 percent. This soil has the profile described as representative of the series. Included in mapping were small areas of Banks loam, Trembles fine sandy loam, Lohler silty clay loam, and Havrelon silty clay loam.

This soil is well drained but has slow runoff. It is susceptible to flooding when ice jams occur. At other times it is protected by the Garrison Dam.

This soil is suited to all crops commonly grown in the county, including irrigated crops. Nearly all the acreage is cropped. The rest is in native grass and trees. The main management needs are conserving moisture and maintaining fertility and tilth. Capability unit IIe-4L; range site not assigned.

Ho—Havrelon silty clay loam. This level soil is on low terraces and bottom land. It occurs as narrow stringers and as large irregularly shaped areas. Slopes are 0 to 1 percent. The surface layer is silty clay loam 6 to 15 inches thick. Otherwise, this soil has a profile similar to the one described as representative of the series. Included in mapping were small areas of Trembles fine sandy loam, Lohler silty clay loam, and Havrelon loam. Also included were a few small areas where the surface layer is silty clay.

This soil is well drained but has slow runoff. It is subject to flooding when ice jams occur. At other times it is protected by the Garrison Dam.

This soil is suited to all crops commonly grown in the county, including irrigated crops. Nearly all the acreage is used for crops. The rest is in native grass and trees. Conserving moisture and maintaining fertility and tilth are the main management needs. Capability unit IIe-4L; range site not assigned.

Heil Series

The Heil series consists of deep, level, poorly drained silty clay loams. These soils formed in calcareous silty clay or clay alluvium in enclosed shallow depressions.

In a representative profile the surface layer is gray silty clay loam about 2 inches thick. The very firm subsoil is dark gray silty clay about 21 inches thick. The underlying material is gray and light gray silty clay.

Permeability is very slow. Runoff ponds. Available water capacity and organic-matter content are moderate. Natural fertility is medium.

Nearly all the acreage is used for range or hay. The native vegetation is mostly western wheatgrass.

Representative profile of Heil silty clay loam in grass 2,400 feet east and 1,550 feet north of southwest corner sec. 34, T. 144 N., R. 81 W.

A2—0 to 2 inches; gray (10YR 5/1) silty clay loam, very dark gray (10YR 3/1) when moist; weak fine platy structure parting to moderate fine granular; slightly hard, very friable, sticky and plastic; many roots; slightly acid; abrupt boundary.

B21t—2 to 4 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) when moist; moderate medium columnar structure parting to moderate medium angular blocky; coating of gray (10YR 5/1), uncoated sand and silt on tops and sides of column; extremely hard, very firm, sticky and plastic; many roots; vertical surface of peds appears glossy when moist; neutral; clear boundary.

B22t—4 to 16 inches; dark gray (10YR 4/1) silty clay, very dark gray (10YR 3/1) when moist; moderate medium and coarse prismatic structure parting to strong medium and fine angular blocky; surface of peds appears glossy when moist; mildly alkaline; clear boundary.

B3—16 to 23 inches; dark gray (5Y 4/1) silty clay, very dark gray (5Y 3/1) when moist; weak coarse prismatic structure parting to moderate medium angular

blocky; extremely hard, very firm, sticky and plastic; few roots; slight effervescence; mildly alkaline; gradual boundary.

C1g—23 to 37 inches; gray (5Y 5/1) silty clay, dark gray (5Y 4/1) when moist; weak medium angular blocky structure; extremely hard, very firm, sticky and plastic; few small masses of gypsum crystals; few soft masses of lime; strong effervescence; moderately alkaline; gradual boundary.

C2g—37 to 46 inches; light gray (5Y 6/1) silty clay, dark gray (5Y 4/1) when moist; massive; extremely hard, very firm, sticky and plastic; common large masses of gypsum crystals; strong effervescence; moderately alkaline; gradual boundary.

C3g—46 to 60 inches; gray (5Y 5/1) silty clay, dark gray (5Y 4/1) when moist; common fine faint olive (5Y 5/4) mottles; massive; extremely hard, very firm, sticky and plastic; slight effervescence; moderately alkaline.

The A2 horizon is mostly silty clay loam but in some places is silt loam. It is gray or light gray and is 1 to 4 inches thick. Some pedons have a 1- to 2-inch thick A1 horizon above the A2 horizon. The B2t horizon is clay or silty clay and is 8 to 20 inches thick. The underlying material ranges from dark gray or olive gray to light gray or pale olive. Mottles do not occur in the Cg horizon in some profiles but are distinct in others. The Cg horizon is silty clay, clay, or clay loam. Glacial till or other contrasting materials occur below 40 inches in some profiles. The depth to carbonates ranges from 15 to more than 38 inches.

Heil soils are associated in the landscape with Dimmick soils. In contrast, they have a columnar B21t horizon.

Hs—Heil silty clay loam. This level soil is in flat enclosed depressions on glacial till uplands and lacustrine plains. Slopes are 0 to 1 percent. This is the only Heil soil mapped in the county. Included in mapping were small areas of Dimmick, Hamerly, Parnell, and Tonka soils.

This soil is poorly drained and is ponded for part of the year. Nearly all the acreage is in native grass and is used for range or hay. A few areas have been cultivated and should be reseeded to grass. Management is needed to maintain good stands of native grass. Capability unit VIs–CD; Closed Depression range site.

Krem Series

The Krem series consists of deep, nearly level to undulating, well drained soils. These soils formed in a sandy mantle over glacial till.

In a representative profile the surface layer is dark grayish brown loamy fine sand about 16 inches thick. The subsoil, about 22 inches thick, is grayish brown and pale brown, very friable loamy fine sand in the upper 12 inches and firm brown and grayish brown clay loam in the lower 10 inches. The underlying material is light brownish gray clay loam.

Permeability is rapid in the upper subsoil and moderately slow in the underlying material. Available water capacity and organic-matter content are high. Natural fertility is medium.

Nearly all the acreage is in native grass, and some is cropped. The native vegetation is mid and short prairie grasses.

Representative profile of Krem loamy fine sand, 1 to 6 percent slopes, 1,320 feet east and 780 feet north of southwest corner sec. 18, T. 145 N., R. 84 W.

A11—0 to 5 inches; dark grayish brown (10YR 4/2) loamy fine sand, very dark brown (10YR 2/2) when moist; weak fine crumb structure; soft, very friable, nonsticky and nonplastic; many fine roots; neutral; gradual boundary.

A12—5 to 16 inches; dark grayish brown (10YR 4/2) loamy fine sand, very dark brown (10YR 2/2) when moist; weak coarse blocky structure; soft, very friable, nonsticky and nonplastic; many fine roots; neutral; gradual boundary.

B21—16 to 21 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; weak coarse blocky structure; soft, very friable, nonsticky and nonplastic; common fine roots; neutral; clear boundary.

B22—21 to 28 inches; pale brown (10YR 6/3) loamy fine sand, dark grayish brown (10YR 4/2) when moist; single grained; loose, very friable, nonsticky and nonplastic; common fine roots; neutral; abrupt boundary.

IIB23t—28 to 34 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) when moist; moderate medium prismatic structure parting to moderate medium blocky; hard, firm, sticky and plastic; continuous clay films on ped faces; few fine roots; a few pebbles; neutral; clear wavy boundary.

IIB3ca—34 to 38 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; weak medium prismatic structure; hard, firm, slightly sticky and slightly plastic; strong effervescence; mildly alkaline; gradual boundary.

IIC1—38 to 60 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; massive; hard, firm, slightly sticky and slightly plastic; few threads and soft masses of lime; a few pebbles; strong effervescence; mildly alkaline.

The A horizon and part of the B horizon formed in loamy fine sand. The IIB and IIC horizons formed in glacial till. The A horizon is commonly loamy fine sand, but in some places is loamy sand. Thin or moderately thick clay films are on ped faces in the IIB horizon.

Krem soils are associated in the landscape with Flaxton, Lihen, Telfer, and Williams soils. They have more sand in the upper B horizon than Flaxton and

Williams soils. They have more clay in the C horizon than Lihen and Telfer soils.

KrB—Krem loamy fine sand, 1 to 6 percent slopes. This nearly level to undulating soil is on till uplands mantled by loamy fine sand material. It is the only Krem soil mapped in the county. Included in mapping were small areas of Lihen, Flaxton, Telfer, Williams, and Zahl soils.

This soil is well drained but has slow runoff.

Most areas are in range, and a few are cropped. The main management concerns are controlling erosion, conserving moisture, and maintaining fertility and tilth. Capability unit IVe–2; Sands range site.

Lallie Series

The Lallie series consists of deep, level, poorly drained soils. These soils are in depressed slack-water areas and oxbows on bottom land. They formed in stratified beds of fine textured alluvium.

In a representative profile the surface layer is gray clay about 3 inches thick. The underlying material is gray and light brownish gray, mottled silty clay and clay to a depth of 42 inches and gray loam and loamy fine sand from 42 to 60 inches.

Permeability is slow. The water table is within 5 feet most of the year and is at or near the surface in spring. Lallie soils are subject to flooding. The available water capacity is high. The natural fertility and organic-matter content are low.

Nearly all the acreage is in native vegetation and is used for pasture. The native plants are sedges, reeds, sloughgrass, and willow. A few areas are drained and used for hay and crops.

Representative profile of Lallie clay in an area of Lallie soils in grassland 1,840 feet west and 800 feet south of northeast corner sec. 18, T. 144 N., R. 82 W.

A1—0 to 3 inches; gray (5Y 5/1) clay, very dark gray (5Y 3/1) when moist; moderate fine granular structure; very hard, firm, sticky and plastic; many fine roots; slight effervescence; neutral; clear boundary.

C1g—3 to 19 inches; gray (5Y 6/1) clay, dark gray (5Y 4/1) when moist; common fine prominent light olive brown (2.5Y 5/4) mottles when moist; weak bedding planes; very hard, firm, sticky and plastic; common fine roots; strong effervescence; neutral; gradual boundary.

C2g—19 to 28 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; common fine distinct gray (5Y 5/1) and light olive brown (2.5Y 5/4) mottles when moist; weak bedding planes; very hard, firm, sticky and plastic; few fine roots; strong effervescence; mildly alkaline; diffuse boundary.

C3g—28 to 42 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; many fine distinct gray (5Y 5/1) and light olive brown (2.5Y 5/4) mottles when moist; weak bedding planes; very hard, firm, sticky and plastic; strong effervescence; mildly alkaline; gradual boundary.

C4g—42 to 50 inches; gray (5Y 6/1) loam, dark gray (5Y 4/1) when moist; many large prominent light olive brown (2.5Y 5/4) mottles when moist; weak bedding planes; hard, firm, slightly sticky and slightly plastic; strong effervescence; mildly alkaline; gradual boundary.

C5g—50 to 60 inches; gray (5Y 6/1) loamy fine sand, dark gray (5Y 4/1) when moist; many large prominent light olive brown (2.5Y 5/6) mottles when moist; massive; slightly hard, very friable, nonsticky and nonplastic; strong effervescence; mildly alkaline.

The A horizon is 2 to 10 inches thick and is gray to dark grayish brown. The texture is typically silty clay but ranges from loam to clay. The C horizon is gray or light brownish gray. Mottles range from few to common and faint to prominent. In some pedons the mottles are mostly yellowish brown, and in others the mottles are gray or greenish gray.

Lallie soils are associated in the landscape with Lohler soils. They are more poorly drained than those soils.

La—Lallie soils. This level mapping unit is in depressed areas in bottom lands. It occurs as narrow stringers in slack-water areas and old oxbows. Slopes are 0 to 1 percent. The surface layer is dominantly silty clay, but ranges from loam to heavy clay. Included in mapping were a few small areas of Lohler and Havrelon soils and a few small areas of marsh.

These soils are very poorly drained. The water table is within 5 feet most of the year and is at or near the surface in spring. Flooding occurs once or twice a year (fig. 9). Runoff is slow.

This unit is suited to crops if excess water is removed. Nearly all the acreage is used for range and pasture. A few areas have been drained and are used for crops and hay. Controlling excess water and maintaining fertility and tilth are the chief management needs. Capability unit IIIw–4; Wetland range site.

Lihen Series

The Lihen series consists of deep, nearly level to hilly, well drained soils. These soils formed in deep sandy material.

In a representative profile the surface layer is dark grayish brown loamy fine sand about 22 inches thick. The underlying material is grayish brown and light brownish gray loamy fine sand and loamy sand.

Permeability is rapid. Available water capacity and organic-matter content are moderate. Natural fertility is medium.

Less than half the acreage is cultivated and used for small grain and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Lihen loamy fine sand, 1 to 6 percent slopes, in native grass, 1,050 feet south and 200 feet west of northeast corner sec. 11, T. 145 N., R. 84 W.

Figure 9.—**Lallie soils are subject to flooding during snowmelt and heavy rains.**

A11—0 to 4 inches; dark grayish brown (10YR 4/2) loamy fine sand, very dark brown (10YR 2/2) when moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; many fine roots; slightly acid; clear boundary.

A12—4 to 22 inches; dark grayish brown (10YR 4/2) loamy fine sand, very dark brown (10YR 2/2) when moist; weak coarse subangular blocky structure; soft, very friable, nonsticky and nonplastic; many fine roots; neutral; gradual boundary.

AC—22 to 35 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; massive; soft, very friable, nonsticky and nonplastic; common fine roots; neutral; gradual boundary.

C1—35 to 47 inches; grayish brown (2.5Y 5/2) loamy fine sand, dark grayish brown (2.5Y 4/2) when moist; single grained; loose, nonsticky and nonplastic, few fine roots; neutral; clear boundary.

C2ca—47 to 51 inches; light brownish gray (2.5Y 6/2) loamy sand, olive brown (2.5Y 4/3) when moist; single grained; loose, nonsticky and nonplastic; about 10 percent gravel; lime coatings on underside of pebbles; strong effervescence; neutral; clear boundary.

C3—51 to 60 inches; grayish brown (2.5Y 5/2) loamy sand, dark grayish brown (2.5Y 4/2) when moist; single grained; loose, nonsticky and nonplastic; strong effervescence; mildly alkaline.

The A horizon is 16 to 30 inches thick and is dark grayish brown or grayish brown. The texture is commonly loamy fine sand, but loamy sand and sandy loam occur in places. The C horizon ranges from grayish brown to light gray and is loamy sand or loamy fine sand. The depth to carbonates ranges from 10 to 36 inches. This horizon is commonly stratified and has some gravel in places. Depth to fine sandy loam or finer textured material is greater than 30 inches.

Lihen soils are associated in the landscape with Parshall, Telfer, and Krem soils. They are more sandy than Parshall soils, have a thicker A horizon than Telfer soils, and have less clay in the C horizon than Krem soils.

LeB—Lihen loamy fine sand, 1 to 6 percent slopes. This nearly level to undulating soil is on hummocky terraces and outwash plains. It has the profile described as representative of the series. Included in mapping were small areas of Telfer loamy fine sand, Parshall fine sandy loam, Krem loamy fine sand, Flaxton fine sandy loam, and Seroco fine sand.

This soil is well drained but has slow runoff. It is highly susceptible to erosion.

Nearly all the acreage is used for native range and pasture. Some areas are cropped. Small grain and alfalfa are the main crops. The main management needs on cropland are controlling soil blowing, conserving moisture, and maintaining fertility and tilth. Capability unit IVe-2; Sands range site.

LeC—Lihen loamy fine sand, 6 to 9 percent slopes. This gently rolling soil is on sandy uplands. It has a profile similar to the one described as representative of the series, except that it has a slightly thinner surface layer. Included in mapping were small areas of Telfer loamy fine sand, Parshall fine sandy loam, Seroco fine sand, Krem loamy fine sand, and Flaxton fine sandy loam.

This soil is well drained but has slow runoff. It is highly susceptible to erosion.

This soil is not suited to crops. Nearly all the acreage is used for native range and pasture. Management is needed to maintain good stands of native grass. Capability unit VIe-Sa; Sands range site.

LgE—Lihen-Zahl complex, 9 to 25 percent slopes. This rolling to hilly mapping unit is on terrace edges and uplands. It occurs along streams that have cut through the sandy mantle and exposed the underlying glacial till and sedimentary beds. It is about 50 percent Lihen loamy fine sand; 25 percent Zahl soil; and 25 percent Flaxton, Krem, Telfer, Cabba, and Flasher soils. The Lihen soil is on the higher parts of the landscape and in swales and on foot slopes. The Zahl soil is on convex slopes and on steep slopes in the lower parts of the landscape. In most areas the surface layer is loamy fine sand. In some areas of the Zahl soil, it is only 1 inch thick.

This unit is well drained and has slow to rapid runoff. It is used for range. It is highly susceptible to erosion and is not suitable for cultivation. Management is needed to maintain good stands of native grass. Capability unit VIe-Sa; Lihen soil in Sands range site; Zahl soil in Thin Upland range site.

Linton Series

The Linton series consists of deep, gently sloping to very steep, well drained soils. These soils formed in deep silty loess material on uplands.

In a representative profile the surface layer is dark grayish brown silt loam about 7 inches thick. The subsoil is very friable silt loam about 22 inches thick. It is grayish brown, light brownish gray, and light gray. The underlying material is light yellowish brown silt loam.

Permeability is moderate. Available water capacity is high. Organic-matter content is moderate. Natural fertility is medium.

Nearly all the acreage is cultivated and used for small grain, corn, and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Linton silt loam in area of Linton-Mandan silt loams, 3 to 6 percent slopes, in cropland 1,250 feet east and 350 feet south of northwest corner sec. 26, T. 147 N., R. 84 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) silty loam, very dark grayish brown (10YR 3/2) when moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; neutral; abrupt smooth boundary.

B21—7 to 14 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; common fine pores; slight effervescence; neutral; clear smooth boundary.

B22—14 to 17 inches; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) when moist; weak medium prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; many fine pores; slight effervescence; mildly alkaline; clear boundary.

B3ca—17 to 29 inches; light gray (2.5Y 7/2) silt loam, grayish brown (2.5Y 5/2) when moist; weak coarse prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; common fine pores; common soft masses of lime; strong effervescence; mildly alkaline; clear boundary.

C1—29 to 60 inches; light yellowish brown (2.5Y 6/3) silt loam, light olive brown (2.5Y 5/3) when moist; slightly hard, very friable, slightly sticky and slightly plastic; strong effervescence; mildly alkaline.

The A horizon is 4 to 8 inches thick and ranges from very dark grayish brown to grayish brown. The B2 horizon is 5 to 10 inches thick and ranges from dark grayish brown to pale brown. The depth to carbonates ranges from 10 to 20 inches. The C horizon is typically silt loam, but in some places coarser or finer textures occur below 40 inches. Lime is segregated in some profiles but is diffused in others.

Linton soils are associated in the landscape with Mandan, Temvik, Grassna, and Wilton soils. They have a thinner A horizon than Mandan and Grassna soils. They differ from Temvik and Wilton soils in not having a IIC horizon.

LmB—Linton-Mandan silt loams, 3 to 6 percent slopes. This gently sloping mapping unit is on loess mantled terraces and uplands. It is about 60 percent Linton silt loam and 40 percent Mandan silt loam. The Linton soil occurs in most of the landscape, and the Mandan soil is in slightly concave areas. The Linton soil has the profile described as representative of the series. Included in mapping were small areas of Grassna, Wilton, and Temvik soils.

This unit is well drained. It has medium runoff and is slightly susceptible to erosion.

This unit is suited to all crops commonly grown in the county. Nearly all the acreage is cropped. A few areas are in native range or pasture. The chief management needs are controlling erosion, conserving

moisture, and maintaining fertility and tilth. Capability unit IIe-5; Silty range site.

LmC—Linton-Mandan silt loams, 6 to 9 percent slopes. This moderately sloping mapping unit is on loess mantled terraces and uplands. It is about 65 percent Linton silt loam and 35 percent Mandan silt loam. The Linton soil is on the upper plane and convex slopes. The Mandan soil is on the lower slopes and in concave areas. Included in mapping were small areas of Grassna, Wilton, and Temvik soils.

This unit is well drained. It has medium runoff and is susceptible to erosion.

This unit is suited to all crops commonly grown in the county. Nearly all the acreage is used for crops. A few areas are in native range. The main management needs are controlling erosion, conserving moisture, and maintaining fertility and tilth. Capability unit IIIe-5; Silty range site.

LmD—Linton-Mandan silt loams, 9 to 15 percent slopes. This strongly sloping mapping unit is on loess mantled terraces and uplands. It is about 65 percent Linton soil and 35 percent Mandan soil. The Linton soil is on the upper plane and convex slopes. The Mandan soil is on the lower slopes and in concave areas. Included in mapping were small areas of Wilton, Grassna, Max, Temvik, and Zahl soils.

This unit is well drained. It has rapid runoff and is highly susceptible to erosion.

This unit is suited to close-seeded crops commonly grown in the county. About half the acreage is used for crops. The rest is in native range or pasture. The main management needs are controlling erosion, conserving moisture, and maintaining fertility and tilth. Capability unit IVe-5; Silty range site.

LmE—Linton-Mandan silt loams, 15 to 40 percent slopes. This moderately steep to very steep mapping unit is on terrace edges and uplands. It is 75 percent Linton soils and 25 percent Mandan soils. Linton soils are on the upper slopes in the landscape, and Mandan soils are on foot slopes and in concave areas. Included in mapping were small areas of Wilton, Grassna, Max, Temvik, and Zahl soils. Also included were a few eroded areas.

This unit is well drained. It has rapid runoff and is highly susceptible to erosion.

This unit is not suited to crops. All of the acreage is used for native range or pasture. Management is needed to maintain good stands of native grass. Capability unit VIe-Si; Silty range site.

Lohler Series

The Lohler series consists of deep, level, moderately well drained soils. These soils are on broad flats or in slightly depressed areas in bottom lands and low terraces. They formed in beds of stratified moderately fine and fine textured alluvium.

In a representative profile the surface layer is grayish brown silty clay loam about 4 inches thick. The underlying material is light brownish gray, grayish brown, and light yellowish brown silt loam, silty clay loam, silty clay, and very fine sandy loam.

Permeability is slow. Available water capacity is high. Natural fertility is medium. Organic-matter content is low.

Nearly all the acreage is cultivated and used for small grain, corn, and alfalfa. The native vegetation is mixed grasses and trees.

Representative profile of Lohler silty clay loam in hayland 2,100 feet south and 2,540 feet west of northeast corner sec. 20, T. 143 N., R. 81 W.

A1—0 to 4 inches; grayish brown (2.5Y 5/2) silty clay loam, very dark grayish brown (2.5Y 3/2) when moist; moderate fine granular structure; hard, friable, sticky and plastic; slight effervescence; neutral; abrupt boundary.

C1—4 to 6 inches; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) when moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; strong effervescence; neutral; abrupt boundary.

C2—6 to 22 inches; grayish brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; weak bedding planes; hard, firm, sticky and plastic; strong effervescence; mildly alkaline; clear boundary.

C3—22 to 35 inches; grayish brown (2.5Y 5/2) light silty clay, dark grayish brown (2.5Y 4/2) when moist; moderate fine angular blocky structure; hard, firm, sticky and plastic; strong effervescence; mildly alkaline; abrupt boundary.

C4—35 to 47 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; few fine distinct mottles of brownish yellow (10YR 6/6); strong fine angular blocky structure; hard, firm, sticky and plastic; few threads of gypsum; strong effervescence; mildly alkaline; abrupt boundary.

C5—47 to 53 inches; light yellowish brown (2.5Y 6/3) very fine sandy loam, olive brown (2.5Y 4/3) when moist; few fine distinct mottles of olive yellow (2.5Y 6/6); massive; soft, very friable, slightly sticky and nonplastic; strong effervescence; mildly alkaline; abrupt boundary.

C6—53 to 60 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; moderate fine angular blocky structure; hard, firm, sticky and plastic; strong effervescence; mildly alkaline.

The A horizon is 2 to 8 inches thick and is grayish brown or light brownish gray. The texture ranges from silt loam to silty clay or clay, but is dominantly silty clay loam or silty clay. The C horizon ranges from grayish brown to pale yellow. It is dominantly silty clay loam and silty clay with a clay content of 35 to 50 percent. Strata of other textures ranging from loamy fine sand to heavy clay occur in places.

The soils are commonly calcareous throughout, but the upper 3 to 6 inches is noncalcareous in some profiles. Some profiles have slight to moderate salinity. In some pedons, there are yellowish brown to strong brown mottles in the lower subsoil and in others there are none.

Lohler soils are associated in the landscape with Havrelon and Lallie soils. They have more clay than Havrelon soils and are better drained than Lallie soils.

Lw—Lohler silty clay loam. This level soil is on low terraces and bottom lands. It occurs as narrow stringers and as large irregularly shaped areas. Slopes are 0 to 1 percent. This soil has the profile described as representative of the series. Included in mapping were small areas of Havrelon silty clay loam, Lallie soils, and other texture phases of Lohler soils.

This soil is moderately well drained. It has slow runoff and is slightly susceptible to erosion. It is subject to flooding from the Missouri River when ice jams occur. At other times it is protected by the Garrison Dam. Runoff from local side streams occasionally flows across the soil and remains ponded in places for a few hours to a few days.

This soil is suited to all crops commonly grown in the county, including irrigated crops. Nearly all the acreage is used for crops. The rest is in native grass and trees. The main management needs are conserving moisture and maintaining fertility and tilth. Capability unit IIe–4L; range site not assigned.

Ly—Lohler silty clay. This level soil is on smooth, low terraces. Slopes are 0 to 1 percent. The surface layer is silty clay; otherwise, this soil has a profile similar to the one described as representative of the series. Included in mapping were small areas of Lohler silty clay loam and Lallie soils.

This soil is moderately well drained, has slow runoff, and is slightly susceptible to erosion. It is subject to flooding from the Missouri River when ice jams occur. At other times it is protected by the Garrison Dam. Runoff from local side streams occasionally flows across and is ponded in places from a few hours to a few days.

This soil is suited to all crops commonly grown in the county, including irrigated crops. Nearly all the acreage is used for crops. The rest is in native grass and trees. The main management needs are controlling soil blowing, conserving moisture, and maintaining fertility and tilth. Capability unit IIs–4; range site not assigned.

Makoti Series

The Makoti series consists of deep, level, moderately well drained soils. These soils formed on nearly level lake plains in the glacial till plains.

In a representative profile the surface laver is dark gray silty clay loam about 6 inches thick. The subsoil, about 13 inches thick, is firm silty clay loam. It is dark grayish brown in the upper 8 inches and grayish brown in the lower 5 inches. The underlying material is light brownish gray and olive yellow silty clay loam, silt loam, and very fine sandy loam.

Permeability is moderately slow. Available water capacity, organic-matter content, and natural fertility are high.

Nearly all the acreage is cultivated and used for small grain, corn, and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Makoti silty clay loam in a cultivated field 190 feet east and 70 feet south of northwest corner sec. 15, T. 149 N., R. 87 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) silty clay loam, very dark brown (10YR 2/2) when moist; moderate medium granular structure; slightly hard, firm, slightly sticky and slightly plastic; few roots; neutral; abrupt smooth boundary.

B21—6 to 14 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark grayish brown (10YR 3/2) when moist; moderate coarse prismatic structure parting to moderate fine subangular blocky; slightly hard, firm, slightly sticky and slightly plastic; few roots; common fine and very fine pores; slightly acid; clear wavy boundary.

B22—14 to 19 inches; grayish brown (2.5Y 5/2) silty clay loam, very dark grayish brown (2.5Y 3/2) when moist; moderate coarse prismatic structure parting to moderate fine subangular blocky; slightly hard, firm, slightly sticky and slightly plastic; few roots; common fine and very fine pores; neutral; clear wavy boundary.

C1ca—19 to 26 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; weak medium prismatic structure parting to weak very fine subangular blocky; slightly hard, friable, slightly sticky and slightly plastic; few roots; common fine and very fine pores; violent effervescence with disseminated lime; mildly alkaline; gradual wavy boundary.

C2ca—26 to 34 inches; light brownish gray (2.5Y 6/2) silt loam, dark grayish brown (2.5Y 4/2) when moist; weak medium subangular blocky structure parting to weak very fine subangular blocky; slightly hard, friable, slightly sticky and nonplastic; few roots; common fine and very fine pores; violent effervescence with disseminated lime; mildly alkaline; gradual wavy boundary.

C3—34 to 46 inches; olive yellow (2.5Y 6/6) stratified silt loam and very fine sandy loam, grayish brown (2.5Y 5/2) when moist; many medium distinct gray (5Y 5/1) moist mottles; slightly hard, friable, slightly sticky and nonplastic; few roots; common fine and very fine pores; lime segregated in fine rounded soft masses; strong effervescence; mildly alkaline; gradual smooth boundary.

C4—46 to 60 inches; light brownish gray (2.5Y 6/2) stratified silty clay loam and very fine sandy loam, olive brown (2.5Y 4/4) when moist; many medium distinct grayish brown (2.5Y 5/2) moist mottles; slightly hard, firm, slightly sticky and slightly plastic; lime segregated in medium rounded soft masses; strong effervescence; moderately alkaline.

The A horizon is 5 to 10 inches thick and is dark gray or dark grayish brown. In most areas the texture is silty clay loam, but silt loam occurs in places. The

B horizon is 6 to 20 inches thick and ranges from very dark grayish brown to light brownish gray. The texture is silty clay loam with 30 to 35 percent clay. Patches of clay films occur in some profiles. The depth to carbonates ranges from 16 to 30 inches. The lower part of the B horizon contains lime in places. The Cca horizon contains lime, both disseminated and as segregated soft masses and threads. The lower C horizon is stratified or varved and commonly contains mottles. In places, glacial till or strata of sand and gravel occur below 40 inches.

Makoti soils are associated in the landscape with Roseglen and Bowbells soils, although they have more silt.

Ma—Makoti silty clay loam. This level soil is on smooth glacial lake plains. It is the only Makoti soil mapped in the county. Slopes are 0 to 1 percent. Included in mapping were areas of Roseglen, Tansem, Sinai, Parnell, Grail, Max, and Williams soils. Also included were areas where the surface layer is silt loam and areas of gently sloping soils.

This soil is moderately well drained and has slow runoff. Nearly all the acreage is used for crops. The rest is in native range and pasture.

This soil is suited to all the crops commonly grown in the county. The main management needs are conserving moisture and maintaining fertility and tilth. Capability unit IIc-7; Silty range site.

Mandan Series

The Mandan series consists of deep, nearly level to moderately sloping, well drained silt loams. These soils formed on loess mantled terraces and uplands.

In a representative profile the surface layer is dark grayish brown silt loam about 10 inches thick. The subsoil is grayish brown, very friable silt loam about 16 inches thick. The underlying material is light brownish gray silt loam.

Permeability and organic-matter content are moderate. Available water capacity and natural fertility are high.

Nearly all the acreage is cultivated for small grain. The native vegetation is mid and short prairie grasses.

Representative profile of Mandan silt loam, 1 to 3 percent slopes, in cropland 2,300 feet north and 65 feet west of southeast corner sec 16, T. 143 N., R. 81 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; weak fine granular structure; slightly hard, very friable, nonsticky and nonplastic; neutral; abrupt boundary.

A12—6 to 10 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; weak coarse prismatic structure; slightly hard, very friable, nonsticky and nonplastic; neutral; clear boundary.

B2—10 to 26 inches; grayish brown (2.5Y 5/2) silt loam, very dark grayish brown (2.5Y 3/2) when moist; weak coarse prismatic structure parting to weak coarse angular blocky; slightly hard, very friable, nonsticky and nonplastic; slight effervescence; neutral; gradual boundary.

C1—26 to 32 inches; light brownish gray (2.5Y 6/2) silt loam, olive brown (2.5Y 4/3) when moist; weak coarse prismatic structure parting to weak coarse angular blocky; slightly hard, very friable, nonsticky and nonplastic; strong effervescence; moderately alkaline; gradual boundary.

C2—32 to 60 inches; light brownish gray (2.5Y 6/2) silt loam, light olive brown (2.5Y 5/3) when moist; massive; slightly hard, very friable, nonsticky and nonplastic; violent effervescence; strongly alkaline.

The A horizon is silt loam 8 to 20 inches thick. The B horizon is dark grayish brown or grayish brown and is 7 to 18 inches thick. The texture is silt loam or very fine sandy loam containing less than 18 percent clay. Some profiles lack a distinct B horizon. The C horizon is silt loam or very fine sandy loam. In places, shale, sand and gravel, or glacial till occurs below 40 inches (fig. 10).

The thickness of the darkened A horizon ranges from 16 to 35 inches. The depth to lime is generally 8 to 20 inches, but a few pedons are limy to the surface.

Mandan soils are associated in the landscape with Linton, Grassna, Temvik, and Wilton soils. They have a thicker A horizon than Linton soils, have less clay in the B horizon than Grassna soils, and have less clay in the C horizon than Temvik and Wilton soils.

MdA—Mandan silt loam, 1 to 3 percent slopes. This nearly level soil is on loess mantled uplands and terraces. It has the profile described as representative of the series. Included in mapping were small areas of Linton, Wilton, Temvik, Grassna, and Williams soils. There are areas totaling about 120 acres, in T. 144 N. and T. 145 N., R. 84 W., that have fine sand at depths of 28 to 40 inches.

This soil is well drained but has slow runoff.

This soil is suited to all the crops commonly grown in the county. Nearly all of the acreage is cropped. The chief management needs are conserving moisture and maintaining fertility and tilth. Capability unit IIe-5; Silty range site.

MdB—Mandan silt loam, 3 to 6 percent slopes. This gently sloping soil is on loess mantled uplands and terraces. Included in mapping were small areas of Linton, Temvik, Wilton, Grassna, and Williams soils. There are areas totaling about 80 acres, in T. 144 N. and T. 145 N., R. 84 W., that have fine sand at depths of 28 to 40 inches.

The soil is well drained but has slow runoff. It is slightly susceptible to erosion.

This soil is suited to all crops commonly grown in the county, including irrigated crops. Nearly all the acreage is in crops. The main management needs are controlling erosion, conserving moisture, and maintaining fertility and tilth. Capability unit IIe-5; Silty range site.

MdC—Mandan silt loam, 6 to 9 percent slopes. This moderately sloping soil is on loess mantled uplands and terraces. Included in mapping were small areas of Linton, Temvik, Wilton, Grassna, and Williams soils.

Figure 10.—**Profile of Mandan silt loam showing sand and gravel below 48 inches.**

This soil is well drained but has medium runoff. It is moderately susceptible to erosion.

This soil is suited to all crops commonly grown in the county. Nearly all the acreage is used for crops. The main management concern is controlling erosion. Conserving moisture and maintaining fertility and tilth are also important. Capability unit IIIe–5; Silty range site.

Manning Series

The Manning series consists of gently to moderately sloping, somewhat excessively drained soils that are moderately deep over sand and gravel. These soils formed in moderately coarse sediment underlain by sand and gravel outwash.

In a representative profile the surface layer is dark grayish brown coarse sandy loam about 6 inches thick. The subsoil is very friable, dark grayish brown coarse sandy loam about 5 inches thick. The underlying material is grayish brown and light brownish gray gravelly loamy coarse sand and coarse sandy loam.

Permeability is moderately rapid in the subsoil and very rapid in the underlying material. Available water capacity is low. Organic-matter content is moderate. Natural fertility is medium.

Nearly all the acreage is cultivated and used for small grain, corn, and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Manning coarse sandy loam in cultivated area of Ruso-Manning coarse sandy loams, 3 to 6 percent slopes, 1,300 feet north and 300 feet east of southwest corner sec. 6, T. 147 N., R. 80 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) coarse sandy loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and nonplastic; neutral; abrupt boundary.

B2—6 to 11 inches; dark grayish brown (10YR 4/2) coarse sandy loam, very dark brown (10YR 2/2) when moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and plastic; neutral; clear boundary.

C1—11 to 21 inches; grayish brown (10YR 5/2) coarse sandy loam, dark grayish brown (10YR 4/2) when moist; very weak medium subangular blocky structure; slightly hard, very friable, slightly sticky and nonplastic; about 10 percent fine gravel; slight effervescence; neutral; gradual boundary.

IIC2—21 to 60 inches; light brownish gray (2.5Y 6/2) gravelly loamy coarse sand, dark grayish brown (10YR 4/2) when moist; single grained; loose, nonsticky and nonplastic; strong effervescence; mildly alkaline.

The depth to the IIC horizon ranges from 20 to 40 inches, and the depth to lime ranges from 10 to 25 inches. The A horizon is 5 to 12 inches thick and is coarse sandy loam or sandy loam. It ranges from dark gray to grayish brown. The B horizon is 12 to 22 inches thick and ranges from dark grayish brown to light olive brown. The texture is coarse sandy loam or sandy loam. The IIC materials range from gravelly sandy loam or loamy sand to coarse sand and gravel.

The content of fine and coarser sand in the upper part of these Manning soils is greater than in the range defined for the series. This difference, however, does not alter use and management.

Manning soils are associated in the landscape with Stady, Parshall, and Ruso soils. They have less clay in the B horizon than Stady soils and have a IIC horizon that is lacking in Parshall soils. They have a thinner A horizon than Ruso soils.

Marysland Series

The Marysland series consists of level, poorly drained soils that are moderately deep over sandy

and loamy material. These soils formed in a loamy mantle of glacial outwash underlain by sand and gravel outwash.

In a representative profile the surface layer is very dark gray and dark gray loam and clay loam about 9 inches thick. The underlying material is light gray and gray clay loam, loamy sand, and sand.

Permeability is moderate in the loamy material and rapid or very rapid in the sand and gravel. Available water capacity is moderate. Organic-matter content is high. Natural fertility is medium.

Nearly all the areas are in native pasture or hay. The native vegetation is sedges, cordgrass, and other tall prairie grasses. If adequately drained, these soils are used for crops.

Representative profile of Marysland loam in hayland 1,000 feet west and 1,600 feet north of southeast corner sec. 21, T. 145 N., R. 82 W.

A11—0 to 4 inches; very dark gray (2.5Y 3/1) loam, black (2.5Y 2/1) when moist; moderate fine granular structure; friable, slightly sticky and slightly plastic; many roots; slight effervescence in spots; neutral; clear boundary.

A12—4 to 9 inches; dark gray (2.5Y 4/1) clay loam, black (2.5Y 2/1) when moist; weak medium prismatic structure parting to moderate medium subangular blocky; friable, sticky and plastic; 5 percent fine gravel, many roots; strong effervescence; neutral; clear boundary.

C1cag—9 to 20 inches; light gray (5Y 7/1) clay loam, light gray to gray (5Y 6/1) when moist; common large distinct light olive brown (2.5Y 5/4) mottles; weak medium subangular blocky structure; friable, sticky and plastic; 5 percent gravel, many roots; violent effervescence; mildly alkaline; abrupt boundary.

IIC2g—20 to 23 inches; gray (5Y 6/1) loamy sand, gray (5Y 5/1) when moist; common large distinct light olive brown (2.5Y 5/4) mottles; single grained; loose, nonsticky and nonplastic; 10 percent gravel, few roots; strong effervescence; mildly alkaline; abrupt boundary.

IIC3g—23 to 26 inches; light gray (5Y 7/1) clay loam, dark gray (5Y 4/1) when moist; few olive brown (2.5Y 5/4) mottles; massive; friable, sticky and plastic; 10 percent fine gravel, few roots; violent effervescence; mildly alkaline; abrupt boundary.

IIC4g—26 to 60 inches; light gray (2.5Y 7/2) stratified loamy sand and sand, light olive brown (2.5Y 5/4) when moist; few small gray (5Y 5/1) mottles; single grained; loose, nonsticky and nonplastic; 10 percent gravel, few roots; strong effervescence; mildly alkaline.

The A horizon is 7 to 16 inches and is dark gray or very dark gray. The Cca horizon is gray or light gray. It has few to many gray, olive brown, or yellowish brown mottles. It ranges from heavy sandy loam to clay loam. The IIC horizon is mixed, calcareous loamy sand, gravelly sand, coarse sand, or gravelly sand. The depth to IIC material ranges from 20 to 40 inches.

Marysland soils are associated in the landscape with Divide, Bowdle, and Stady soils. They are more poorly drained.

Mf—Marysland loam. This level soil occurs in low and slightly concave areas in the glacial outwash plain. Slopes are 0 to 1 percent. This is the only Marysland soil mapped in the county. Included in mapping were small areas of Colvin, Divide, Bowdle, and Stady soils.

This soil is poorly drained and has slow runoff. It is slightly susceptible to erosion.

Nearly all the acreage is in native pasture. A few drained areas are used for crops. Management is needed to control excess water and erosion and to maintain fertility and tilth. Capability unit IVw–4L; Wet Meadow range site.

Max Series

The Max series consists of deep, undulating to steep, well drained soils. These soils formed in loamy glacial till.

In a representative profile the surface layer is dark grayish brown loam about 5 inches thick. The subsoil is dark grayish brown, friable loam about 4 inches thick. The underlying material is light brownish gray and light olive brown loam and clay loam.

Permeability is moderate in the subsoil and moderately slow in the underlying material. Available water capacity is high. Organic-matter content is moderate, and natural fertility is medium.

These soils are used mostly for crops. The native vegetation is mid and short prairie grasses.

Representative profile of Max loam in cultivated area of Max-Zahl loams, 6 to 9 percent slopes, 140 feet east and 1,700 feet south of northwest corner sec. 5, T. 149 N., R. 81 W.

Ap—0 to 5 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; mildly alkaline; abrupt smooth boundary.

B2—5 to 9 inches; dark grayish brown (10YR 4/2) heavy loam, very dark brown (10YR 3/3) when moist; peds coated with very dark grayish brown (10YR 3/2) moist; moderate medium prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and slightly plastic; common fine roots; few fine pores; patches of clay films on vertical faces; mildly alkaline; clear wavy boundary.

C1ca—9 to 17 inches; light brownish gray (2.5Y 6/3) loam, olive brown (2.5Y 4/3) when moist; moderate coarse prismatic structure; hard, friable, slightly sticky and slightly plastic; common fine roots; few fine pores; few films and soft masses of lime; strong effervescence; mildly alkaline; gradual wavy boundary.

C2ca—17 to 37 inches; light olive brown (2.5Y

5/3) clay loam, olive brown (2.5Y 4/3) when moist; many medium distinct gray (5Y 5/1) and dark yellowish brown (10YR 4/4) moist mottles; weak coarse prismatic structure; hard, friable, sticky and plastic; few fine pores; common films and soft masses of lime; strong effervescence; moderately alkaline; gradual wavy boundary.

C3—37 to 60 inches; light olive brown (2.5Y 5/3) clay loam, olive brown (2.5Y 4/3) when moist; many large distinct gray (5Y 5/1), olive (5Y 4/4), and dark brown (7.5YR 4/4) moist mottles; massive; very hard, firm, sticky and plastic; very few roots; few pores; very few soft masses of lime; strong effervescence; moderately alkaline.

The B horizon is loam or clay loam. Depth to carbonates ranges from 8 to 16 inches. The profile is 1 to 10 percent pebbles and stones.

Max soils are associated in the landscape with Williams, Zahl, Bowbells, and Arnegard soils. They have less clay accumulation in the B horizon than Williams soils. They differ from Zahl soils in having a B horizon. They have a thinner A horizon than Bowbells and Arnegard soils.

MgB—Max loam, 3 to 6 percent slopes. This undulating soil is on glacial till uplands. Included in mapping were small areas of Williams, Bowbells, and Zahl soils and small areas of Tonka and Parnell soils in undrained depressions.

This soil is well drained and has medium runoff. It is suited to all crops commonly grown in the county. Most of the acreage is used for crops. The rest is in native range or pasture. Control of erosion, conservation of moisture, and maintenance of fertility and tilth are the chief concerns of management. Capability unit IIe–6; Silty range site.

MhC—Max-Bowbells-Zahl loams, 6 to 9 percent slopes. This gently rolling mapping unit is in glacial till landscapes. It is about 35 percent Max loam, 30 percent Bowbells loam, 25 percent Zahl loam, and 10 percent minor soils. Max loam is on side slopes. Bowbells loam is on lower side slopes and in concave parts of the landscape. Zahl loam is on ridges and the higher convex slopes. Included in mapping were small areas of Williams and Arnegard soils and areas of Tonka and Parnell soils in undrained depressions.

This unit is moderately well drained and well drained. Runoff is medium to rapid. The erosion hazard is moderate.

This mapping unit is used for crops and range. It is suited to all crops commonly grown in the county. Control of erosion is an essential part of management. Conserving moisture and maintaining fertility and tilth are also important. Capability unit IIIe–6; Max and Bowbells soils in Silty range site, Zahl soil in Thin Upland range site.

MlC—Max-Zahl loams, 6 to 9 percent slopes. This gently rolling mapping unit is on glacial till uplands. It is about 65 percent Max loam, 25 percent Zahl loam, and 10 percent Bowbells and Williams soils. The Max soil is on side slopes. The Zahl soil is on convex ridges. Bowbells and Williams soils occur on the gentler slopes and in concave areas. The profiles of the major soils are the ones described as representative of the Max and Zahl series. Included in mapping were small areas of Tonka and Parnell soils in undrained depressions.

This unit is well drained. Runoff is medium to rapid. The erosion hazard is moderate.

This unit is suited to crops commonly grown in the county. More than half the acreage is cultivated. The rest is in native range or pasture. Control of erosion is an essential part of management. Conserving moisture and maintaining fertility and tilth are also important. Contour stripcropping is generally not practical because of the short irregular slopes. Capability unit IIIe–6; Max soil in Silty range site; Zahl soil in Thin Upland range site.

MlD—Max-Zahl loams, 9 to 15 percent slopes. This rolling mapping unit is on uplands. It is 60 percent Max loam and 40 percent Zahl loam. The Max soil is on side slopes. The Zahl soil is in the steepest part of the landscape and on convex ridges. Included in mapping were small areas of Williams, Bowbells, Arnegard, Tonka, and Parnell soils.

This unit is well drained and has rapid runoff. The erosion hazard is severe.

The unit is suited to small grain and alfalfa. About half the acreage is cultivated. The rest is in native range or pasture. Control of erosion is an essential part of management. Conserving moisture and maintaining fertility and tilth are also important. Capability unit IVe–6; Max soil in Silty range site; Zahl soil in Thin Upland range site.

Miranda Series

The Miranda series consists of deep, nearly level to strongly sloping, moderately well drained soils. These soils formed in alkaline loamy glacial till.

In a representative profile the surface layer is dark gray and gray loam about 4 inches thick. The subsoil is very firm, dark grayish brown clay loam about 15 inches thick. The underlying material is light yellowish brown clay loam.

Permeability is very slow. Available water capacity and natural fertility are low. Organic-matter content is moderate.

Nearly all the acreage is in native vegetation and is used for native range or pasture. The native vegetation is a sparse stand of alkali-tolerant prairie grasses.

Representative profile of Miranda loam in grassy area of Noonan-Miranda complex, 1 to 6 percent slopes, 50 feet north and 2,015 feet east of southwest corner sec. 36, T. 150 N., R. 89 W.

A21—0 to 2 inches; gray (10YR 5/1) loam, very dark gray (10YR 3/1) when moist; weak fine subangular blocky structure parting to weak very fine platy; slightly hard, friable, slightly sticky and nonplastic; common fine roots; many very fine pores; medium acid; abrupt smooth boundary.

A22—2 to 4 inches; gray (10YR 5/1) loam, very dark gray (10YR 3/1) when moist; moderate medium prismatic structure parting to weak medium platy; slightly hard, friable, slightly sticky and non-

plastic; common fine roots; many very fine pores; neutral; abrupt wavy boundary.

B2t—4 to 12 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 2/2) when moist; strong coarse columnar structure parting to strong coarse blocky; very hard, very firm, sticky and plastic; few fine roots; common very fine pores; thin continuous clay films; mildly alkaline; gradual wavy boundary.

B3sa—12 to 19 inches; dark grayish brown (2.5Y 5/2) clay loam, very dark grayish brown (2.5Y 3/2) when moist; moderate medium prismatic structure parting to moderate medium angular blocky; hard, firm, sticky and slightly plastic; few very fine roots and pores; patches of clay films; few masses of gypsum and salts; tongues of organic staining on ped faces; mildly alkaline; gradual wavy boundary.

C1sa—19 to 23 inches; light yellowish brown (2.5Y 6/3) clay loam, light olive brown (2.5Y 5/3) when moist; common fine distinct dark brown (7.5YR 4/4) moist mottles; weak coarse subangular blocky structure parting to weak fine subangular blocky; slightly hard, firm, slightly sticky and nonplastic; common masses of gypsum and salts; violent effervescence; strongly alkaline; diffuse boundary.

C2—23 to 60 inches; light yellowish brown (2.5Y 6/4) clay loam, olive brown (2.5Y 4/4) when moist; common large distinct gray (5Y 5/1) moist and dark reddish brown (5YR 3/4) moist mottles; massive; slightly hard, firm, slightly sticky and nonplastic; many soft masses of lime; few masses of gypsum crystals; strong effervescence; strongly alkaline.

The A horizon is 1 to 4 inches thick and is gray or dark gray. It is typically loam but ranges to silt loam and very fine sandy loam. In a few places a thin A1 horizon overlies the A2 horizon. The combined thickness of the A1 and A2 horizon is less than 5 inches. The B2t horizon is 5 to 10 inches thick. It ranges from very dark gray to grayish brown and is clay loam or light clay. A thin to thick clay film coats the ped faces. No gypsum occurs in places in the B3 horizon. Masses of salts and gypsum occur within 16 inches of the surface. Tongues of darkened material commonly extend into the B3 horizon and in some areas into the C horizon. The depth to carbonates ranges from 8 to 20 inches. The C horizon commonly contains a few to many masses of gypsum crystals and lime masses. It is saline or alkaline loamy glacial till.

Miranda soils are associated in the landscape with Noonan and Williams soils. They lack the A1 horizon that occurs in Noonan soils and have a higher sodium content than Williams soils. They have a thinner solum than Noonan soils and have more coarse sand and pebbles in the underlying material than Rhoades soils.

Morton Series

The Morton series consists of moderately deep, gently to moderately sloping well drained loams on uplands. These soils formed in soft shale.

In a representative profile the surface layer is dark grayish brown loam about 7 inches thick. The subsoil is friable silty clay loam about 11 inches thick. It is grayish brown and light brownish gray. The underlying material is light olive gray silt loam. Shale is at 38 inches.

Permeability and organic-matter content are moderate. Available water capacity is high. Natural fertility is medium.

About half the acreage is in crops and is used for small grain and alfalfa. The rest is in native vegetation and is used for range or pasture.

Representative profile of Morton loam, 3 to 9 percent slopes, in rangeland 470 feet east and 140 feet south of northwest corner sec. 18, T. 145 N., R. 80 W.

A1—0 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate medium angular blocky structure; hard, friable, slightly sticky and slightly plastic; neutral; clear boundary.

B21t—7 to 12 inches; grayish brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate medium prismatic structure parting to strong medium blocky; hard, friable, slightly sticky and slightly plastic; common very fine pores; thin continuous clay films; neutral; gradual boundary.

B22t—12 to 15 inches; grayish brown (2.5Y 5/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate medium prismatic structure parting to moderate medium blocky; hard, friable, slightly sticky and slightly plastic; common very fine pores; patches of clay films; slight effervescence; neutral; clear boundary.

B3ca—15 to 18 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; moderate coarse angular blocky structure; hard, friable, slightly sticky and slightly plastic; common very fine pores; few fine roots; few threads and soft masses of lime; strong effervescence; neutral; gradual boundary.

C1ca—18 to 38 inches; light olive gray (5Y 6/2) silt loam, olive gray (5Y 5/2) when moist; moderate medium angular blocky structure; hard, friable, nonsticky and slightly plastic; few fine roots; few threads and soft masses of lime; violent effervescence; neutral; gradual boundary.

C2—38 to 60 inches; pale olive (5Y 6/3) soft shale, olive (5Y 4/3) when moist; hard, friable, slightly sticky and slightly plastic; strong effervescence; moderately alkaline.

The A horizon is 4 to 12 inches thick and is dark grayish brown or grayish brown. The B horizon is 6 to 16 inches thick and ranges from dark grayish brown to pale brown. The texture is dominantly silty clay loam. Clay films are thin continuous or patchy. Depth to carbonates ranges from 11 to 24 inches. The Cca horizon has disseminated lime throughout and contains few to common soft masses and threads of lime. Depth to soft shale ranges from 20 to 40 inches. Shale is bedded and has a platy structure in some places and is massive in others.

Morton soils are associated in the landscape with Williams, Arnegard, Regent, and Grail soils. They are less deep than Williams soils, have a thinner A horizon than Arnegard and Grail soils, and contain less clay in the B horizon than Regent soils.

MoC—Morton loam, 3 to 9 percent slopes. This gently to moderately sloping soil is on shale uplands. It is the only Morton soil mapped in the county. Included in mapping were areas of Regent, Farnuf, Grail, Cabba, and Williams. Also included were soils that have a profile similar to the profile of this Morton soil but contain more sand and less silt.

This soil is well drained and has medium runoff. It is moderately susceptible to erosion.

About half the acreage is used for crops, and the rest is used for range or pasture. The main management needs are controlling water erosion, conserving moisture, and maintaining fertility and tilth. Capability unit IIIe-6; Silty range site.

Niobell Series

The Niobell series consists of deep, nearly level and gently sloping, moderately well drained soils on plane or in slightly concave positions. These soils formed in glacial till.

In a representative profile the surface layer is dark grayish brown loam about 7 inches thick. The next layer is gray loam about 4 inches thick. The firm subsoil is dark grayish brown, brown, and light yellowish brown clay loam about 14 inches thick. The underlying material is light brownish gray and light yellowish brown clay loam.

Permeability is slow. Available water capacity is high. Organic-matter content is moderate. Natural fertility is medium.

Nearly all the acreage is cultivated and is used for small grain, corn, and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Niobell loam in cultivated area of Niobell-Williams loams, 1 to 3 percent slopes, 1,050 feet east and 125 feet south of northwest corner sec. 7, T. 149 N., R. 84 W.

A1—0 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; weak medium subangular blocky structure parting to moderate fine granular; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; slightly acid; clear boundary.

A&B—7 to 11 inches; gray (10YR 5/1) loam, very dark gray (10YR 3/1) when moist; light gray on upper surface of plates; moderate medium blocky structure parting to weak medium and fine platy; hard, very friable, slightly sticky and slightly plastic; many fine roots; many fine pores; a few patchy clay films; slightly acid; clear boundary.

B21t—11 to 16 inches; dark grayish brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) when moist; moderate medium prismatic structure parting to strong medium blocky; very hard, firm, sticky and plastic; common fine roots; many fine pores; continuous clay films on ped faces; thin coating of bleached fine sand and silt on tops and sides of prisms; some gravel; slightly acid; clear wavy boundary.

B22t—16 to 20 inches; brown (10YR 5/3) clay loam, dark brown (10YR 4/3) when moist; moderate medium prismatic structure parting to strong medium and fine blocky; very hard, firm, sticky and plastic; common fine roots; many fine pores; continuous clay films on ped faces; grayish brown (10YR 5/2) coatings on ped faces; some gravel; neutral; clear wavy boundary.

B3ca—20 to 25 inches; light yellowish brown (2.5Y 6/3) clay loam, light olive brown (2.5Y 5/3) when moist; moderate medium prismatic structure parting to strong medium blocky; hard, firm, sticky and plastic; common fine roots; common fine pores; a few grayish brown (2.5Y 5/2) coatings on ped faces; few soft masses of lime; some gravel; strong effervescence; mildly alkaline; clear irregular boundary.

C1ca—25 to 34 inches; light brownish gray (2.5Y 6/2) clay loam, grayish brown (2.5Y 5/2) when moist; weak medium prismatic structure parting to moderate medium subangular blocky; hard, firm, slightly sticky and slightly plastic; few fine roots; few fine pores; common soft masses of lime; some gravel; strong effervescence; moderately alkaline; gradual boundary.

C2—34 to 60 inches; light yellowish brown (2.5Y 6/4) light clay loam, light olive brown (2.5Y 5/4) when moist; few fine distinct light yellowish brown (10YR 6/4) moist mottles; massive; hard, friable, slightly sticky and slightly plastic; few soft masses of lime; a few masses of salt and gypsum; some gravel; strong effervescence; moderately alkaline.

The A horizon is 6 to 15 inches thick. It is dark gray to grayish brown in the upper part and dark gray to light brownish gray in the lower part. In most areas a thin layer at the lower boundary of this horizon is platy. The B2t horizon has a texture of clay loam with 28 to 35 percent clay. Bleached fine sand and silt from the A horizon extend into the B horizon and coat the sides and upper part of prisms and blocks. The B horizon is alkaline and contains sodium.

The solum ranges from 16 to 30 inches in thickness. The C horizon has some segregated lime and some visible salt and gypsum crystals. The amount of visible salt crystals and segregated lime varies within individual profiles and within short distances.

Niobell soils are associated in the landscape with Noonan and Williams soils. They lack the columnar B2 horizon that occurs in Noonan soils and have a higher sodium content than Williams soils.

NbA—Niobell-Williams loams, 1 to 3 percent slopes. This nearly level mapping unit is on glacial till uplands. It is about 65 percent Niobell loam, 25 percent Williams loam, and 10 percent minor soils. The Niobell soil occurs on the plane or slightly concave lower slopes in the landscape, and the Williams soil in slightly convex areas. The Niobell soil has the profile described as representative of the series. Included in mapping were small areas of Noonan, Miranda, Bowbells, Max, and Tonka soils.

This unit is moderately well drained and well drained and has medium runoff. It is slightly susceptible to erosion. The alkaline subsoil restricts roots and water movement.

This unit is well suited to all crops commonly grown in the county. Nearly all the acreage is used for crops. The rest is in native range or pasture. The chief management needs are conserving moisture and maintaining fertility and tilth. Capability unit IIIs-6P; Niobell soil in Clayey range site, Williams soil in Silty range site.

NbB—Niobell-Williams loams, 3 to 6 percent slopes. This gently sloping mapping unit is on glacial till uplands. It is about 65 percent Niobell loam, 25 percent Williams loam, and 10 percent minor soils. The Niobell soil occurs on the plane or slightly concave slopes in the landscape. The Williams soil is on the high parts of the landscape. Included in mapping were small areas of Noonan, Miranda, Bowbells, Max, and Tonka soils. Also included were a few areas where slopes are more than 6 percent.

This unit is moderately well drained and well drained and has medium runoff. It is moderately susceptible to erosion. The alkaline subsoil restricts roots and water movement.

This unit is well suited to all crops commonly grown in the county. Nearly all the acreage is used for crops. The rest is in native range or pasture. The chief management needs are controlling erosion, conserving moisture, and maintaining fertility and tilth. Capability unit IIIe-6P; Niobell soil in Clayey range site; Williams soil in Silty range site.

Noonan Series

The Noonan series consists of deep, nearly level to strongly sloping, moderately well drained soils on till plains. These soils formed in alkaline loam or clay loam glacial till.

In a representative profile the surface layer is about 8 inches thick. It is dark grayish brown loam in the upper 6 inches and gray silt loam in the lower 2 inches. The subsoil is dark grayish brown, very firm and firm clay loam about 14 inches thick. The underlying material is grayish brown and light yellowish brown clay loam.

Permeability is slow. Available water capacity and organic-matter content are moderate. Natural fertility is medium.

Nearly all the acreage is in native vegetation, which is mid and short prairie grasses.

Representative profile of Noonan loam in area of Noonan-Miranda complex, 1 to 6 percent slopes, in native pasture 200 feet south and 1,100 feet east of northwest corner sec. 7, T. 149 N., R. 84 W.

A1—0 to 6 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; medium acid; clear boundary.

A2—6 to 8 inches; gray (10YR 5/1) silt loam, very dark gray (10YR 3/1) when moist, light gray (10YR 6/1) on upper sides of plates; weak medium subangular blocky structure parting to weak fine platy; slightly hard, very friable, nonsticky and slightly plastic; many fine roots; many fine pores; slightly acid; clear wavy boundary.

B21t—8 to 12 inches; dark grayish brown (10YR 4/2) clay loam, very dark brown (10YR 2/2) when moist; strong medium columnar structure parting to strong medium blocky; extremely hard, very firm, sticky and plastic; few fine roots; few fine pores; continuous clay films on ped faces; mildly alkaline; clear wavy boundary.

B22t—12 to 18 inches; dark grayish brown (10YR 4/2) clay loam, very dark grayish brown (10YR 3/2) when moist; extremely hard, very firm, sticky and plastic; few fine roots; few fine pores; continuous clay films on vertical faces and patches of clay films on horizontal ped faces; moderately alkaline; clear wavy boundary.

B3sa—18 to 22 inches; dark grayish brown (2.5Y 4/2) clay loam, very dark grayish brown (2.5Y 3/2) when moist; weak medium prismatic structure parting to moderate medium subangular blocky; very hard, firm, sticky and plastic; few fine roots, common masses of salts and gypsum; moderately alkaline; clear wavy boundary.

C1sa—22 to 27 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; few fine distinct light olive brown (2.5Y 5/6) mottles; weak medium prismatic structure parting to moderate medium subangular blocky; hard, friable, sticky and slightly plastic; few fine roots; few tongues of dark grayish brown (2.5Y 4/2) on ped faces; common masses of salts and gypsum; slight effervescence in spots; moderately alkaline; clear wavy boundary.

C2casa—27 to 35 inches; light yellowish brown (2.5Y 6/3) clay loam, olive brown (2.5Y

4/3) when moist; few fine distinct light olive brown (2.5Y 5/6) moist mottles; massive; hard, friable, sticky and slightly plastic; few masses of salts and gypsum; common soft masses of lime; strong effervescence; strongly alkaline; gradual boundary.

C3—35 to 60 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; few fine distinct yellowish brown (10YR 5/6) and few fine faint gray (5Y 4/1) moist mottles; massive; hard, firm, sticky and slightly plastic; strong effervescence; strongly alkaline.

The A horizon is 3 to 9 inches thick. It is dark gray to grayish brown in the upper part and gray or light gray in the lower part. The A2 horizon is ½ inch to 4 inches thick and is gray, light brownish gray, or light gray. In cultivated areas, this horizon is commonly incorporated into the Ap horizon.

The B2t horizon is dark grayish brown to light brownish gray. It is typically clay loam and is 27 to 35 percent clay. This horizon ranges from mildly to strongly alkaline. Salts are in the lower part of some profiles.

The C horizon is firm loam or clay loam glacial till and contains accumulations of lime in the upper part. It also contains salt crystals.

Noonan soils are associated in the landscape with Niobell, Williams, and Miranda soils. They differ from Niobell and Williams soils in having a columnar B2 horizon. They differ from Miranda soils in having an A1 horizon.

NmB—Noonan-Miranda complex, 1 to 6 percent slopes. This nearly level and gently sloping mapping unit is on glacial till uplands. It is about 70 percent Noonan loam and 30 percent Miranda loam. The Noonan soil is continuous in the landscape. The Miranda soil is discontinuous. Areas are small, circular, or irregular. The profiles of these soils are the ones described as representative of their respective series. Included in mapping were small areas of Niobell, Williams, Bowbells, Max, and Grail soils.

This unit is moderately well drained. It has medium runoff and is moderately susceptible to erosion. The alkaline subsoil restricts roots and water movement.

Nearly all the acreage is in native range or pasture. Some areas are cultivated. A chief management need is controlling erosion. Conserving moisture and maintaining fertility and tilth are also important needs. Capability unit IVs–6P; Noonan soil in Claypan range site; Miranda soil in Thin Claypan range site.

NmD—Noonan-Miranda complex, 6 to 15 percent slopes. This moderately and strongly sloping mapping unit is on glacial till uplands. It is about 70 percent Noonan loam and 30 percent Miranda loam. The Noonan soil is continuous in the landscape. The Miranda soil is discontinuous. Areas are small, circular, or irregular. Included in mapping were small areas of Niobell, Williams, Bowbells, Zahl, Grail, and Max soils.

This unit is moderately well drained. It has rapid runoff and is highly susceptible to erosion. The alkaline subsoil restricts roots and water movement.

Nearly all the acreage is in native range or pasture. Management is needed to maintain good stands of native grasses. Capability unit VIe–CP; Noonan soil in Claypan range site; Miranda soil in Thin Claypan range site.

Nutley Series

The Nutley series consists of deep, nearly level and gently sloping, well drained silty clay soils. These soils formed in calcareous glacio-lacustrine sediment.

In a representative profile the surface layer is dark gray silty clay about 8 inches thick. The subsoil is firm silty clay about 22 inches thick. It is dark grayish brown in the upper 6 inches and grayish brown and light brownish gray in the lower 16 inches. The underlying material is light brownish gray, yellowish brown, and light gray silty clay.

Permeability is slow. Available water capacity is high. Natural fertility is medium. Organic-matter content is moderate.

Nearly all the acreage is cultivated and used for small grain, corn, and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Nutley silty clay, 1 to 3 percent slopes, in a cultivated field 2,600 feet east and 2,140 feet south of the northwest corner sec. 21, T. 145 N., R. 79 W.

Ap—0 to 6 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) when moist; weak fine granular structure; very hard, friable, sticky and plastic; slightly acid; abrupt boundary.

A12—6 to 8 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) when moist; moderate medium and coarse angular blocky structure parting to moderate fine angular blocky; very hard, friable, sticky and plastic; slightly acid; clear boundary.

B21—8 to 14 inches; dark grayish brown (2.5Y 4/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; tongues of black (10YR 2/1) moist coatings on sides of peds; moderate coarse angular blocky structure parting to moderate medium subangular; very hard, firm, sticky and plastic; strong effervescence; neutral; clear boundary.

B22—14 to 26 inches; grayish brown (2.5Y 5/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; strong medium and coarse angular blocky structure parting to strong fine angular blocky; very hard, firm, sticky and plastic; strong effervescence; neutral; gradual boundary.

B23—26 to 30 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; strong medium and coarse angular blocky structure parting to strong fine angular blocky; very hard, firm, sticky and plastic; strong effervescence; neutral; gradual boundary.

C1—30 to 38 inches; light brownish gray (2.5Y

6/2) silty clay, dark grayish brown (2.5Y 4/3) when moist; massive; very hard, firm, sticky and plastic; strong effervescence; neutral; gradual boundary.

C2—38 to 51 inches; light brownish gray (2.5Y 6/3) silty clay, olive brown (2.5Y 4/4) when moist; massive; very hard, firm, sticky and plastic; strong effervescence; neutral; gradual boundary.

C3—51 to 60 inches; yellowish brown (10YR 5/4) and light gray (5Y 6/1) silty clay, dark yellowish brown (10YR 4/4) and dark gray (5Y 4/1) when moist; massive; very hard, firm, sticky and plastic; strong effervescence; neutral.

The A horizon is 4 to 8 inches thick and is dark gray or gray. The B horizon is 10 to 24 inches thick and ranges from dark gray or dark grayish brown to light brownish gray. The texture is silty clay that is 40 to 70 percent clay. Tongues of dark organic stains range from few to common. The C horizon is clay or silty clay. Thin tongues of dark organic stains extend into the C horizon in some places. The C horizon is commonly varved material or pockets of till-like materials. The thickness of the darkened A horizon ranges from 6 to 16 inches.

The annual precipitation received by these Nutley soils is a few inches less than that defined as typical of the series, but this difference does not alter use or management.

Nutley soils are associated in the landscape with Sinai and Grano soils but are better drained than those soils.

NtA—Nutley silty clay, 1 to 3 percent slopes. This nearly level soil is on smooth glacio-lacustrine plains. It has the profile described as representative of the series. Included in mapping were small areas of Williams, Sinai, Makoti, and Parnell soils.

This soil is well drained and has medium runoff. It is slightly susceptible to erosion.

This soil is suited to all crops commonly grown in the county. Nearly all the acreage is used for crops. The rest is in native range or pasture. The main management needs are controlling erosion, conserving moisture, and maintaining fertility and tilth. Capability unit IIs–4; Clayey range site.

NtB—Nutley silty clay, 3 to 6 percent slopes. This gently sloping soil is on smooth glacio-lacustrine plains. Included in mapping were small areas of Williams, Makoti, Sinai, and Parnell soils.

This soil is well drained. It has medium runoff and is moderately susceptible to erosion.

This soil is suited to all crops commonly grown in the county Nearly all the acreage is used for crops. The rest is in native range or pasture. The main management needs are controlling erosion, conserving moisture, and maintaining fertility and tilth. Capability unit IIIe–4; Clayey range site.

Orthents

Or—Orthents, loamy, occurs as spoil banks and spoil piles in areas that have been strip mined. The spoil banks and piles are coal fragments, fragments of shale and sandstone, and glacial till. Slopes are irregular and steep with gradients up to 100 percent. The vegetation ranges from barren in some recently stripped areas to a fair stand of sweetclover, grasses, and trees in areas that were mined many years ago. Unless vegetated, the material erodes rapidly.

Orthents, loamy, has little agricultural value. It is best suited to wildlife. Some of the better vegetated areas can be used for limited grazing. Areas can be reclaimed by leveling and applying topsoil. Capability unit VIIs–1; range site not assigned.

Parnell Series

The Parnell series consists of deep, level, very poorly drained silty clay loams in depressions. These soils formed in local alluvium from glacial drift.

In a representative profile the surface layer is dark gray silty clay loam about 8 inches thick. The subsoil is dark gray silty clay about 30 inches thick. The underlying material is light olive gray and yellowish brown silty clay loam and clay loam.

Permeability is slow. Available water capacity, organic-matter content, and natural fertility are high.

Nearly all the acreage is used for pasture and hay.

Representative profile of Parnell silty clay loam in pasture 1,150 feet east and 800 feet south of northwest corner sec. 23, T. 146 N., R. 80 W.

Ap—0 to 5 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) when moist; moderate fine granular structure; hard, friable, slightly sticky and plastic; common fine roots; medium acid; abrupt boundary.

A12—5 to 8 inches; dark gray (10YR 4/1) silty clay loam, black (10YR 2/1) when moist; moderate fine platy structure; hard, friable, slightly sticky and slightly plastic; common fine roots; medium acid; abrupt boundary.

B21tg—8 to 20 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) when moist; weak medium prismatic structure parting to strong fine angular blocky; very hard, firm, very sticky and very plastic; few fine roots; patches of clay films on ped faces; slightly acid; gradual boundary.

B22tg—20 to 38 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) when moist; weak fine angular blocky structure; very hard, firm, very sticky and very plastic; few fine roots; patches of clay films; slightly acid; gradual boundary.

C1g—38 to 50 inches; light olive gray (5Y 6/2) silty clay loam, olive gray (5Y 4/2) moist; common fine faint gray (5Y 5/1) mottles; massive; very hard, firm, sticky and plastic; few dark coatings on peds; neutral; clear boundary.

IIC2g—50 to 60 inches; yellowish brown (10YR 5/6) clay loam, dark yellowish brown (10YR 4/4) moist; common medium distinct light olive gray (5Y 6/2) mottles;

massive; very hard, firm, sticky and plastic; few pebbles; slight effervescence; mildly alkaline.

The A horizon is typically more than 30 inches thick. Most profiles are noncalcareous to 30 inches or more, but in some places lime is near the surface and there is no distinct lime zone. In some places glacial till occurs within 40 inches of the surface, but in other places the alluvium is more than 5 feet thick.

Parnell soils are associated in the landscape with Tonka, Williams, Hamerly, Max, and Bowbells soils, but they are more poorly drained.

Pa—Parnell silty clay loam. This level soil is in depressions. It has the profile described as representative of the series. Slopes are 0 to 1 percent. Because runoff from snowmelt and from high intensity rain collects in depressions, water ponds from early in spring to midsummer. Included in mapping were small areas of Tonka, Hamerly, Colvin, and Dimmick soils.

This soil is very poorly drained. Unless drained, it is ponded during about half of the growing season.

If excess water is removed, this soil is suited to all crops commonly grown in the county. Nearly all the acreage is used for hay and pasture. Hay can be cut more than half the years. The chief limitation is very poor drainage. The chief management needs are controlling water and maintaining fertility and tilth. Capability unit IIIw–7; Wetland range site.

Pe—Parnell silty clay loam, very wet. This level soil is in deeper depressions. Slopes are 0 to 1 percent. Because runoff from snowmelt and from high intensity rain collects in depressions, water ponds on the surface during nearly all the growing season. Included in mapping were small areas of Parnell silty clay loam, Hamerly loam, Dimmick clay, and Marsh.

Part of the acreage is used for pasture and range. Part is idle. In most years hay cannot be cut because the soil is too wet. Capability unit Vw–WL; Wetland range site.

Parshall Series

The Parshall series consists of deep, nearly level to strongly sloping, well drained soils. These soils formed in outwash and alluvial material.

In a representative profile the surface layer is dark grayish brown fine sandy loam about 5 inches thick. The subsoil is dark grayish brown and grayish brown, very friable fine sandy loam about 22 inches thick. The underlying material is grayish brown and light brownish gray fine sandy loam and loamy fine sand.

Permeability is moderate or moderately rapid in the upper part and moderately rapid in the lower part. Available water capacity is moderate. Organic-matter content is high. Natural fertility is medium.

Representative profile of Parshall fine sandy loam, 3 to 6 percent slopes, in cultivated field 2,200 feet east and 100 feet north of southwest corner sec. 10, T. 144 N., R. 83 W.

A1—0 to 5 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) when moist; moderate medium granular structure; slightly hard, very friable, slightly sticky and nonplastic; neutral; abrupt boundary.

B21—5 to 15 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) when moist; weak coarse prismatic structure; slightly hard, very friable, nonsticky and nonplastic; common fine roots; neutral; gradual boundary.

B22—15 to 27 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak coarse prismatic structure; slightly hard, very friable, nonsticky and nonplastic; common fine roots; neutral; clear boundary.

C1—27 to 36 inches; grayish brown (2.5Y 5/2) sandy loam, olive brown (2.5Y 4/3) when moist; massive; soft, very friable, nonsticky and nonplastic; few fine roots; slight effervescence; neutral; gradual boundary.

C2—36 to 60 inches; light brownish gray (2.5Y 6/2) loamy sand, olive brown (2.5Y 4/3) when moist; massive; soft, very friable, nonsticky and nonplastic; few fine roots; strong effervescence; mildly alkaline.

The depth to carbonates ranges from 24 to 60 inches. The A horizon is fine sandy loam or loam. The C horizon ranges from sandy loam to loamy fine sand. In places there is small gravel. Some profiles have a gravelly substratum below 40 inches.

Parshall soils are associated in the landscape with Flaxton, Lihen, Manning, and Ruso soils. They have less clay in the C horizon than Flaxton soils and less sand in the upper C horizon than Lihen soils. They lack the IIC horizon that occurs in Manning and Ruso soils.

PhA—Parshall fine sandy loam, 1 to 3 percent slopes. This nearly level soil is on terraces and outwash plains. Included in mapping were areas of Parshall loam, Lihen loamy fine sand, and Flaxton fine sandy loam.

This soil is well drained but has slow runoff.

This soil is suited to all crops commonly grown in the county. Nearly all the acreage is cropped. The rest is native range or pasture. The chief management needs are controlling soil blowing, conserving moisture, and maintaining fertility and tilth. Capability unit IIIe–3; Sandy range site.

PhB—Parshall fine sandy loam, 3 to 6 percent slopes. This gently sloping or undulating soil is on terraces and outwash plains. It has the profile described as representative of the series. Included in mapping were areas of Parshall loam, Flaxton fine sandy loam, and Lihen loamy fine sand.

This soil is well drained but has slow runoff.

This soil is suited to all crops commonly grown in the county. Nearly all the acreage is cropped. The rest is in native range or pasture. The chief management needs are controlling soil blowing and water erosion. Conserving moisture and maintaining fertility and tilth are also necessary. The soil is subject to gullying where water concentrates. Capability unit IIIe–3; Sandy range site.

PhC—Parshall fine sandy loam, 6 to 9 percent slopes. This gently rolling soil is on uplands and outwash plains. It has a profile similar to that described as

representative of the series, but it has a thinner surface layer. Included in mapping were areas of Flaxton fine sandy loam and Lihen loamy fine sand. Also included were a few areas that have a loam surface layer.

This soil is well drained but has slow runoff.

This soil is suited to all crops commonly grown in the county. It is subject to gullying in areas where water concentrates. Nearly all the acreage is cropped. The rest is in native range or pasture. The main management need is controlling erosion. Conserving moisture and maintaining fertility and tilth are also necessary. Capability unit IVe-3; Sandy range site.

PhD—Parshall fine sandy loam, 9 to 15 percent slopes. This strongly sloping soil is on outwash plains and uplands. It is about 70 percent Parshall fine sandy loam and 30 percent a similar soil that has a thinner surface layer. Parshall soils are on the smooth side slopes and in swales. The thin surfaced soil is on the steeper and convex parts of the landscape. Included in mapping were areas of Lihen loamy fine sand and Flaxton fine sandy loam.

This soil is well drained and has medium runoff.

This soil is not suited to crops. Nearly all the acreage is in range. A few areas are cropped, but should be seeded to grass. Management is needed to maintain good stands of grass. Capability unit VIe-Sy; Sandy range site.

PoA—Parshall loam, 1 to 3 percent slopes. This nearly level soil is on terraces and outwash plains. Its profile is similar to the one described as representative of the series, but the surface layer is loam. Included in mapping were small areas of Parshall fine sandy loam, Flaxton fine sandy loam, and Wilton silt loam. Also included were a few areas where the surface layer is silt loam.

This soil is well drained but has slow runoff. It is slightly susceptible to erosion. Organic-matter content is high.

This soil is suited to all crops commonly grown in the county. Nearly all the acreage is cropped. The rest is in native range or pasture. The chief management needs are conserving moisture and maintaining fertility and tilth. Capability unit IIe-5; Sandy range site.

PoB—Parshall loam, 3 to 6 percent slopes. This undulating and gently sloping soil is on terraces and outwash plains. Its profile is similar to the one described as representative of the series, but the surface layer is loam. Included in mapping were small areas of Parshall fine sandy loam, Flaxton fine sandy loam, and Wilton silt loam. Also included were a few small areas that have a silt loam surface.

This soil is well drained. The available water capacity is moderate. Natural fertility is medium.

This soil is suited to all crops commonly grown in the county. Nearly all the acreage is cropped. The rest is in native range or pasture. The main management needs are controlling erosion, conserving moisture, and maintaining fertility and tilth. Capability unit IIe-5; Sandy range site.

Regent Series

The Regent series consists of moderately deep, gently and moderately sloping, well drained silty clay loams. These soils formed from soft shale.

In a representative profile the surface layer is dark grayish brown silty clay loam about 6 inches thick. The subsoil is firm, dark grayish brown silty clay, about 10 inches thick. The underlying material is light brownish gray silty clay loam. Shale is at 35 inches.

Permeability is slow. Available water capacity is high. Natural fertility is medium. Organic-matter content is moderate.

Nearly all the acreage is cropped. The native vegetation is mid and short prairie grasses.

Representative profile of Regent silty clay loam, 3 to 9 percent slopes, in cultivated field 1,200 feet north and 150 feet west of southeast corner sec. 29, T. 149 N., R. 85 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silty clay loam, very dark brown (10YR 2/2) when moist; strong fine granular structure; hard, firm, sticky and plastic; neutral; abrupt boundary.

B21t—6 to 13 inches; dark grayish brown (10YR 4/2) silty clay, very dark brown (10YR 2/2) when moist; strong medium to fine prismatic structure parting to strong medium angular blocky; very hard, firm, sticky and plastic; common fine pores; continuous clay films; neutral; gradual boundary.

B22t—13 to 16 inches; dark grayish brown (2.5Y 4/2) silty clay, very dark grayish brown (2.5Y 3/2) when moist; moderate medium prismatic structure parting to moderate medium angular blocky; very hard, firm, sticky and plastic; few small lime segregations, common fine pores; continuous clay films; strong effervescence in spots; neutral; gradual boundary.

C1ca—16 to 26 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; weak medium prismatic structure parting to moderate medium angular blocky; very hard, firm, sticky and plastic; few fine pores; common films and threads of lime; strong effervescence; mildly alkaline; gradual boundary.

C2—26 to 35 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; massive; very hard, firm, sticky and plastic; few fine pores; few threads of lime; strong effervescence; moderately alkaline; gradual boundary.

C3—35 to 60 inches; gray to light gray (5Y 6/1) soft platy shale, dark gray (5Y 4/1) when moist; strata of light yellowish brown (2.5Y 6/4) and light olive brown (2.5Y 5/6) when moist; strong effervescence; moderately alkaline.

The depth to soft shale is 30 to 40 inches. The soft shale is mainly silty clay loam but in places is stratified with silt loam. The A horizon is dark grayish brown or grayish brown. The B2t horizon is silty clay loam

or silty clay with 35 to 45 percent clay content. It is dark grayish brown, grayish brown, or light brownish gray. This horizon has thin to moderately thick clay films. Most profiles have a B3ca horizon or Cca horizon with segregations of lime.

Regent soils are associated in the landscape with Morton and Grail soils. They have more clay than Morton soils and a thinner A horizon than Grail soils.

RgC—Regent silty clay loam, 3 to 9 percent slopes. This gently and moderately sloping soil is on upland plains. It is the only Regent soil mapped in the county. Included in mapping were small areas of Morton, Cabba, Grail, Arnegard, Vebar, and Flasher soils.

The soil is well drained. It has medium runoff and is moderately susceptible to erosion.

This soil is suited to all crops commonly grown in the county. Nearly all the acreage is cropped. The rest is used for range and pasture. The main management need is controlling water erosion. Conserving moisture and maintaining fertility and tilth are also necessary. Capability unit IIIe–7; Clayey range site.

Rhoades Series

The Rhoades series consists of deep, nearly level to moderately sloping, moderately well drained loams on terraces, foot slopes, or uplands. These soils formed in alluvium or from soft shale.

In a representative profile the surface layer is grayish brown loam about 3 inches thick. The very firm clay subsoil is dark grayish brown and about 12 inches thick. The underlying material is light brownish gray and olive gray clay and clay loam.

Permeability is slow or very slow. Available water capacity and natural fertility are low. Organic-matter content is moderate.

Nearly all the acreage is used for pasture. The native vegetation is a sparse stand of short grasses.

Representative profile of Rhoades loam, 1 to 9 percent slopes, in pasture 1,600 feet north and 600 feet west of southeast corner sec. 33, T. 149 N., R. 85 W.

A2—0 to 3 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; weak fine platy structure; slightly hard, very friable, nonsticky and nonplastic; medium acid; abrupt boundary.

B21t—3 to 8 inches; dark grayish brown (10YR 4/2) clay, very dark brown (10YR 2/2) when moist; strong medium and coarse columnar structure parting to moderate medium angular blocky; extremely hard, very firm, very sticky and very plastic; continuous clay films; few fine pores; mildly alkaline; clear boundary.

B22t—8 to 15 inches; dark grayish brown (2.5Y 4/2) clay, very dark grayish brown (2.5Y 3/2) when moist; moderate medium prismatic structure parting to strong medium angular blocky; extremely hard, very firm, very sticky and very plastic; continuous clay films; few fine pores; few threads of lime; strong effervescence; moderately alkaline; clear boundary.

C1cs—15 to 22 inches; light brownish gray (2.5Y 6/2) clay, dark grayish brown (2.5Y 4/2) when moist; weak medium prismatic structure parting to moderate medium angular blocky; extremely hard, very firm, sticky and plastic; few fine pores; many segregations of lime and gypsum; strong effervescence; moderately alkaline; gradual boundary.

C2—22 to 50 inches; light brownish gray (2.5Y 6/2) light clay, dark grayish brown (2.5Y 4/2) when moist; massive; very hard, firm, sticky and plastic; few segregations of salts and gypsum; strong effervescence; mildly alkaline; gradual boundary.

C3—50 to 60 inches; olive gray (5Y 5/2) clay loam, olive gray (5Y 4/2) when moist; massive; hard, firm, sticky and plastic; few segregations of salts and gypsum; strong effervescence; mildly alkaline.

The A1 and A2 horizons have a combined thickness of 1 to 5 inches. The texture is usually loam or very fine sandy loam. The B2t horizon is commonly darker than the A horizon. Clay films and organic stains coat the faces of the columns. The C horizon is clay loam, silty clay, or loam transported or weathered from shale; depth to shale is commonly more than 30 inches. This horizon is moderately or strongly alkaline and calcareous and has few to common salt crystals.

Rhoades soils are associated in the landscape with Grail, Morton, and Regent soils, but they have a higher sodium content.

RhB—Rhoades complex, 1 to 9 percent slopes. This nearly level to moderately sloping mapping unit is on terraces or side slopes. The landscape is one of recurring slight highs and lows that have a difference in elevation of 1 to 6 inches over short distances. The unit is dominantly Rhoades soil. The surface layer ranges from loam to very fine sandy loam. Dispersed areas occur where the claypan is near the surface. In these areas vegetation is sparse.

About 60 percent of the total acreage is Rhoades soil. Other soils included in mapping were Farnuf, Grail, Regent, Morton, and Williams soils. Soils with natric horizons were also included. These soils are similar to Niobell and Noonan soils, but they formed in alluvium or from shale.

The Rhoades soil is moderately well drained and has medium runoff. It is highly susceptible to erosion.

Nearly all the acreage is used for pasture. This unit is not suited to crops. Management is needed to maintain good stands of native grass. Capability unit VIs–TCP; Thin Claypan range site.

Riverwash

Rm—Riverwash occurs as sand bars and mud bars in the flood channels and adjacent to the main channels, only on the flood plains of the Missouri River. The bars are out of the water most of the year, but they are unstable because the materials are shifted at the varying water levels. They are flooded one or more times each year when water is released from Garrison Dam. Some of the lower areas are barren of vegeta-

tion. Others have a cover of annual weeds, sweetclover, or willow.

Riverwash is not used for farming or grazing. It is suitable for wildlife and recreation. Capability unit VIIIe-1; range site not assigned.

Roseglen Series

The Roseglen series consists of deep, level to moderately sloping, moderately well drained soils on glaciolacustrine and outwash plains.

In a representative profile the surface layer is dark grayish brown silt loam about 6 inches thick. The subsoil is grayish brown and light olive brown very friable silt loam and loam about 19 inches thick. The underlying material is pale yellow and light yellowish brown loam.

Permeability is moderate. Available water capacity, organic-matter content, and natural fertility are high.

Nearly all the acreage is cultivated and used for small grain, corn, and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Roseglen silt loam in cultivated field 2,250 feet west and 150 feet north of southeast corner sec. 3, T. 145 N., R. 83 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; neutral; abrupt boundary.

B2—6 to 22 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; few very fine pores; neutral; clear boundary.

B3—22 to 25 inches; light olive brown (2.5Y 5/3) loam, dark grayish brown (2.5Y 4/2) when moist; moderate medium prismatic structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine pores; slight effervescence; neutral; clear boundary.

C1ca—25 to 37 inches; pale yellow (2.5Y 7/3) loam, light olive brown (2.5Y 5/3) when moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; common threads and soft masses of lime; few fine pores; strong effervescence; mildly alkaline; gradual boundary.

C2—37 to 60 inches; light yellowish brown (2.5Y 6/3) loam, olive brown (2.5Y 4/3) when moist; massive; slightly hard, very friable, slightly sticky and slightly plastic; strong effervescence; mildly alkaline.

The solum is 20 to 38 inches thick. The darkened surface layer is more than 16 inches thick. The A horizon is 6 to 10 inches thick and is very dark grayish brown to grayish brown. The B2 horizon ranges from very dark grayish brown to brown. A C1ca horizon is lacking in some profiles. The texture is silt loam or loam. The calcareous C horizon is stratified loam and silt loam. There are threads and nodules of lime in most profiles.

Roseglen soils are associated in the landscape with Tansem, Makoti, and Williams soils. They are darker to a greater depth than Tansem soils. They have more sand than Makoti soils. In contrast with Williams soils, they do not have a clay accumulation in the B2 horizon.

Ro—Roseglen silt loam. This level soil is on smooth glacial lake plains. Slopes are 0 to 1 percent. This soil has the profile described as representative of the series. Included in mapping were small areas of Parnell, Makoti, Tansem, Tonka, and Williams soils.

This soil is moderately well drained and has slow runoff. It is slightly susceptible to erosion.

This soil is suited to all crops commonly grown in the county. Nearly all the acreage is cropped. The rest is in native range or pasture. The chief management needs are conserving moisture and maintaining fertility and tilth. Capability unit IIc-6; Silty range site.

RpB—Roseglen-Tansem complex, 3 to 6 percent slopes. This gently sloping mapping unit is on glacial lake plains. It is about 60 percent Roseglen soil and 40 percent Tansem soil. Roseglen silt loam is on the lower parts of the landscape. Tansem loam is on the upper parts.

The Tansem soil has the profile described as representative of the series. Included in mapping were small areas of Makoti, Max, Parnell, Parshall, Tonka, Williams, and other soils.

This unit is moderately well drained and well drained. It has medium runoff and is slightly susceptible to erosion.

Nearly all the acreage is cropped. The rest is in native range or pasture. This unit is suited to all crops commonly grown in the county. Capability unit IIe-6; Silty range site.

RpC—Roseglen-Tansem complex, 6 to 9 percent slopes. This moderately sloping mapping unit is on small glacial lake plains intermixed with glacial till areas. It is about 45 percent Roseglen silt loam, 40 percent Tansem loam, and 15 percent minor soils. The Roseglen soil has a slightly thinner solum than the one described as representative of the series. Included in mapping were small areas of Max, Williams, Parshall, and Zahl soils.

This unit is moderately well drained and well drained. It has medium runoff and is moderately susceptible to erosion.

Nearly all the acreage is cropped. The rest is in native range or pasture. This unit is suited to all crops commonly grown in the county. Capability unit IIIe-6; Silty range site.

Ruso Series

The Ruso series consists of nearly level to moderately sloping, well drained soils that are moderately deep over sand and gravel. These soils formed in moderately coarse sediment that is underlain by sand and gravel outwash.

In a representative profile the surface layer is dark grayish brown, coarse sandy loam about 14 inches thick. The subsoil is grayish brown friable coarse sandy loam about 8 inches thick. The underlying material is grayish brown, light brownish gray, olive

gray, and yellowish brown gravelly loamy coarse sand, very gravelly loamy coarse sand, and gravelly coarse sand.

Permeability is moderately rapid in the subsoil and very rapid in the underlying material. Available water capacity is low. Organic-matter content is moderate. Natural fertility is medium.

Nearly all the acreage is cultivated and used for small grain, corn, and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Ruso coarse sandy loam, 1 to 3 percent slopes, in cultivated field 120 feet south and 20 feet east of center of sec. 4, T. 147 N., R. 80 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) coarse sandy loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; neutral; abrupt smooth boundary.

A12—6 to 14 inches; dark grayish brown (10YR 4/2) coarse sandy loam, very dark brown (10YR 2/2) when moist; weak coarse subangular blocky structure parting to moderate fine granular; slightly hard, very friable, slightly sticky and nonplastic; many fine roots; neutral; clear smooth boundary.

B2—14 to 22 inches; grayish brown (10YR 5/2) coarse sandy loam, very dark grayish brown (10YR 3/2) when moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable, slightly sticky and slightly plastic; many fine roots; many fine pores; very dark brown (10YR 2/2) moist coatings on ped faces; neutral; clear wavy boundary.

IIC1ca—22 to 28 inches; grayish brown (2.5Y 5/2) gravelly loamy coarse sand, dark grayish brown (2.5Y 4/2) when moist; single grained; loose, nonsticky and nonplastic; common fine roots; violent effervescence, lime segregated in common soft masses; mildly alkaline; clear irregular boundary.

IIC2ca—28 to 36 inches; light brownish gray (2.5Y 6/2) very gravelly loamy coarse sand, grayish brown (2.5Y 5/2) when moist; single grained; loose, nonsticky and nonplastic; few fine roots; violent effervescence; lime segregated in many soft masses; mildly alkaline; clear irregular boundary.

IIC3ca—36 to 50 inches; olive gray (5Y 5/2) and yellowish brown (10YR 5/4) gravelly coarse sand, olive gray (5Y 4/2) and dark yellowish brown (10YR 4/4) when moist; single grained; loose, nonsticky and nonplastic; few roots; strong effervescence; gradual boundary.

IIC4—50 to 60 inches; yellowish brown (10YR 5/4) gravelly coarse sand, dark yellowish brown (10YR 4/4) when moist; single grained; loose, nonsticky and nonplastic; slight effervescence; moderately alkaline.

The depth to sand and gravel ranges from 20 to 40 inches, and the depth to lime ranges from 20 to 34 inches. The A horizon is 8 to 16 inches thick and is coarse sandy loam, sandy loam, and loamy sand. It ranges from dark brown to grayish brown. The B horizon is 6 to 15 inches thick. It ranges from dark grayish brown to light olive brown and is coarse sandy loam and sandy loam. In most areas it is noncalcareous throughout, but in places it is limy in the lower part. Typically, there is a little gravel in the A horizon and B2 horizon. The underlying material is stratified gravelly loamy sand to very gravelly coarse sand.

Ruso soils are associated in the landscape with Manning, Stady, Bowdle, Wabek, and Parshall soils. They have a thicker A horizon than Manning soils and have less clay in the B horizon than Stady and Bowdle soils. They have a B horizon that Wabek soils lack and have a IIC horizon that Parshall soils lack.

RsA—Ruso coarse sandy loam, 1 to 3 percent slopes. This nearly level soil is on terraces and glacial outwash plains. It has the profile described as representative of the series. Included in mapping were small areas of Manning, Wabek, Bowdle, and Stady soils. Also included were a few areas that have a gravelly surface.

This soil is well drained. It has slow runoff and is moderately susceptible to erosion.

This soil is suited to irrigated crops. Nearly all the acreage is cropped and used for small grain and alfalfa. The main management needs are controlling soil blowing, conserving moisture, and maintaining fertility. Capability unit IIIes-3; Sandy range site.

RtB—Ruso-Manning coarse sandy loams, 3 to 6 percent slopes. This gently sloping mapping unit is on terraces and glacial outwash plains. It is about 70 percent Ruso coarse sandy loam and 30 percent Manning coarse sandy loam. The Manning soil has the profile described as representative of the series. Included in mapping were small areas of Wabek, Bowdle, Stady, and Max soils and a few areas that have a gravelly surface.

This unit is well drained and somewhat excessively drained. It has slow runoff and is moderately susceptible to erosion.

This unit is suited to irrigated crops. More than half the acreage is cropped. Small grain and alfalfa are the main crops. The main management needs are controlling soil blowing, conserving moisture, and maintaining fertility and tilth. Capability unit IIIes-3; Sandy range site.

RtC—Ruso-Manning coarse sandy loams, 6 to 9 percent slopes. This moderately sloping mapping unit is on terraces and glacial outwash plains. It is about 55 percent Ruso coarse sandy loam, 30 percent Manning coarse sandy loam, and 15 percent Wabek soils. The Wabek soil is on the convex ridges and steep slopes. Included in mapping were areas of Bowdle, Stady, Parshall, Lihen, Max, and Zahl soils. Also included were a few areas where the surface is gravelly.

This unit is well drained and somewhat excessively drained. It has slow runoff and is highly susceptible to erosion.

Less than half the acreage is cropped. The rest is used for native range or pasture. Small grain and alfalfa are the main crops. The main management need on cropland is controlling soil blowing and water erosion. Conserving moisture and maintaining fertility and tilth are also necessary. Capability unit IVes–3; Sandy range site.

RxB—Ruso-Manning complex, 3 to 6 percent slopes. This gently sloping mapping unit is on terraces and glacial outwash plains. It is about 60 percent Ruso soils, 30 percent Manning soils, and 10 percent Wabek soils. The profiles of these soils are similar to the ones described as representative of their respective series, but the surface layer is loamy sand, loamy coarse sand, or coarse sandy loam. The steep Wabek soil is on convex ridges. Included in mapping were small areas of Lihen and Parshall soils. Also included were a few areas that have a gravelly surface.

This unit is well drained and somewhat excessively drained. It has slow runoff and is moderately susceptible to erosion. It is also droughty.

This unit is suited to irrigated crops. Nearly all the acreage is cropped. Small grain and alfalfa are the main crops. The main management need is controlling soil blowing. Conserving moisture and maintaining fertility and tilth are also necessary. Capability unit IIIes–33; Sandy range site.

RyC—Ruso-Wabek complex, 6 to 9 percent slopes. This moderately sloping mapping unit is on terraces and glacial outwash plains. It is about 50 percent Ruso soils, 30 percent Wabek soils, and 20 percent Manning soils. The Wabek soil is on the higher convex parts of the landscape. The profiles of these soils are similar to the ones described as representative of their respective series, but the surface layer is loamy sand, loamy coarse sand, or coarse sandy loam. Included in mapping were small areas of Lihen and Parshall series. Also included were a few areas where the surface is gravelly.

This unit is well drained and excessively drained. It has slow runoff and is highly susceptible to erosion. It is also droughty.

Less than half the acreage is cropped. The rest is used for native range and pasture. Small grain and alfalfa are the main crops. The main management needs are controlling soil blowing and water erosion. Conserving moisture and maintaining fertility and tilth are also necessary. Capability unit IVes–3; Ruso soil in Sandy range site, Wabek soil in Very Shallow range site.

RzA—Ruso soils, 1 to 3 percent slopes. These nearly level soils are on terraces and glacial outwash plains. They have a profile similar to the one described as representative of the series except the surface layer is loamy sand, loamy coarse sand, or coarse sandy loam. Included in mapping were small areas of Lihen, Parshall, Wabek, and Manning soils. Also included were a few areas that have a gravelly surface.

These soils are well drained. They have slow runoff and are moderately susceptible to erosion. They are also droughty.

These soils are suited to irrigated crops. Nearly all the acreage is cropped. Small grain and alfalfa are the main crops. The main management need is controlling soil blowing. Conserving moisture and maintaining fertility and tilth are also necessary. Capability unit IIes–33; Sandy range site.

Seroco Series

The Seroco series consists of deep, rolling to hilly, excessively drained soils on sandy uplands. The landscape is hammocky or dunelike. These soils formed in windblown sands and in coarse textured deposits left by glacial melt water.

In a representative profile the surface layer is grayish brown fine sand about 4 inches thick. The underlying material is light yellowish brown fine sand.

Permeability is rapid. Available water capacity is very low. Organic-matter content and fertility are low.

These soils are highly susceptible to erosion and are not suitable for cultivation. All the acreage is in native range. The native vegetation is prairie sandreed and other native grasses and a few shrubs.

Representative profile of Seroco fine sand, 9 to 25 percent slopes, in grassland 800 feet west and 1,100 feet south of northeast corner sec. 13, T. 145 N., R. 84 W.

A1—0 to 4 inches; grayish brown (10YR 5/2) fine sand, very dark grayish brown (10YR 3/2) when moist; weak fine granular structure; loose, nonsticky and nonplastic; neutral; gradual boundary.

C—4 to 60 inches; light yellowish brown (2.5Y 6/3) fine sand, olive brown (2.5Y 4/3) when moist; single grained; loose, nonsticky and nonplastic; neutral.

The A horizon ranges from 2 to 6 inches in thickness and is grayish brown or light brownish gray. In most areas the C horizon is fine sand, but it ranges from loamy fine sand to sand. In places there are thin, buried layers where wind action has covered an old surface layer. Most profiles are noncalcareous to 60 inches.

Seroco soils are associated in the landscape with Banks and Telfer soils. They differ from Banks soils in not having stratification in the C horizon. They have a thinner A horizon than Telfer soils.

SeD—Seroco fine sand, 9 to 25 percent slopes. This is the only Seroco soil mapped in the county. It has the profile described as representative of the series. The landscape is rolling to hilly or choppy. Old blowouts have revegetated. Included in mapping were areas of Telfer and Lihen soils in swales and concave areas.

This soil is excessively drained. Runoff is very slow.

This soil is highly susceptible to erosion. It is not suitable for cultivation. All the acreage is used for native range. Management is needed to maintain good stands of native grasses. Capability unit VIIe–TSa; Thin Sands range site.

Sinai Series

The Sinai series consists of deep, level, moderately well drained silty clay soils. These soils formed in glacio-lacustrine sediment.

In a representative profile the surface layer is very dark gray silty clay about 7 inches thick. The subsoil is dark grayish brown, firm silty clay about 14 inches

thick. The underlying material is light yellowish brown and light brownish gray silty clay.

Permeability is slow. Available water capacity, organic-matter content, and natural fertility are high.

Nearly all the acreage is cultivated and used for small grain, corn, and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Sinai silty clay in a cultivated field 155 feet south and 560 feet west of the northeast corner, sec. 26, T. 148 N., R. 85 W.

Ap—0 to 7 inches; very dark gray (10YR 3/1) silty clay, black (10YR 2/1) when moist; moderate coarse granular structure; very hard, firm, sticky and plastic; neutral; abrupt smooth boundary.

B2—7 to 21 inches; dark grayish brown (10YR 4/2) silty clay, very dark grayish brown (10YR 3/2) when moist; weak coarse prismatic structure parting to moderate fine subangular blocky; very hard, firm, sticky and plastic; neutral; clear wavy boundary.

C1ca—21 to 37 inches; light yellowish brown (2.5Y 6/4) silty clay, light olive brown (2.5Y 5/4) when moist; many medium distinct gray (5Y 5/1) mottles; weak coarse subangular blocky structure parting to moderate fine subangular blocky; hard, firm, sticky and plastic; strong effervescence; mildly alkaline; gradual wavy boundary.

C2—37 to 46 inches; light brownish gray (2.5Y 6/2) silty clay, olive brown (2.5Y 4/4) when moist; many large distinct dark gray (5Y 4/1) mottles; massive; hard, firm, sticky and plastic; many soft masses of lime; strong effervescence; moderately alkaline; clear wavy boundary.

C3—46 to 60 inches; light brownish gray (2.5Y 6/2) silty clay, dark grayish brown (2.5Y 4/2) when moist; few medium faint gray (5Y 5/1) and few fine prominent dark red (5YR 3/6) mottles; massive; hard, firm, sticky and plastic; slight effervescence; moderately alkaline.

The A horizon ranges from very dark gray to grayish brown. The B2 horizon is 7 to 16 inches thick and ranges from dark gray to light brownish gray. It is dominantly silty clay, but strata of silt loam or silty clay loam are common. The clay content ranges from 35 to 60 percent. The C horizon has lime throughout and contains lime masses and threads in some pedons.

The annual precipitation received by these Sinai soils is a few inches less than in the range defined for the series, but this difference does not alter use and management.

Sinai soils are associated in the landscape with Dimmick and Nutley soils. They are better drained than Dimmick soils but not so well drained as Nutley soils.

Sn—Sinai silty clay. This level soil is on terraces and broad, level areas on uplands. Slopes are 0 to 1 percent. This is the only Sinai soil mapped in the county. Included in mapping were small areas of Nutley, Dimmick, Tonka, and Parnell soils.

This soil is moderately well drained. It has medium runoff and is slightly susceptible to erosion.

This soil is suited to all crops commonly grown in the county. Nearly all the acreage is cropped. The main management needs are controlling erosion, conserving moisture, and maintaining fertility and tilth. Capability unit IIs–4; Clayey range site.

Stady Series

The Stady series consists of gently sloping to moderately sloping, well drained soils that are moderately deep over sand and gravel. These soils formed in a loamy mantle of glacial outwash that is underlain by sand and gravel outwash.

In a representative profile the surface layer is dark grayish brown loam about 9 inches thick. The subsoil is friable loam about 16 inches thick. It is dark grayish brown in the upper 5 inches and grayish brown and light yellowish in the lower 11 inches. The underlying material is light yellowish brown very gravelly sand.

These soils have slow runoff. Permeability is moderate in the subsoil and very rapid in the underlying material. Available water capacity and organic-matter content are moderate. Natural fertility is medium.

Nearly all the acreage is cultivated and used for small grain and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Stady loam in an area of Bowdle-Stady loams, 3 to 6 percent slopes, in cultivated field 2,100 feet south and 800 feet east of northwest corner sec. 2, T. 144 N., R. 81 W.

Ap—0 to 9 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; weak fine granular structure; slightly hard, friable, nonsticky and nonplastic; neutral; abrupt boundary.

B21—9 to 14 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate coarse prismatic structure parting to moderate medium and coarse blocky; hard, friable, nonsticky and nonplastic; neutral; clear boundary.

B22—14 to 20 inches; grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) when moist; moderate coarse prismatic structure parting to moderate medium and coarse blocky; hard, friable, slightly sticky and slightly plastic; few thin clay films; neutral; clear boundary.

B3ca—20 to 25 inches; light yellowish brown (2.5Y 6/3) loam, olive brown (2.5Y 4/3) when moist; weak coarse prismatic structure parting to moderate medium and coarse blocky; hard, friable, slightly sticky and slightly plastic; common threads and soft masses of lime; strong effervescence; mildly alkaline; abrupt boundary.

IIC1—25 to 53 inches; light yellowish brown (2.5Y 6/3) very gravelly sand, olive brown (2.5Y 4/3) when moist; structureless; loose, nonsticky and nonplastic;

lime coating on underside of gravel; strong effervescence; mildly alkaline; gradual boundary.

IIC2—53 to 60 inches; light yellowish brown (2.5Y 6/3) very gravelly sand, olive brown (2.5Y 4/3) when moist; structureless; loose, nonsticky and nonplastic; strong effervescence; mildly alkaline.

The solum is 15 to 30 inches thick. The A horizon is 4 to 10 inches thick and is dark grayish brown or grayish brown. The B horizon is 5 to 17 inches thick and is typically grayish brown loam. It is noncalcareous in the upper part and is typically calcareous in the lower part. The loamy upper mantle commonly contains 1 to 5 percent gravel. In some places a Cca horizon has formed in the loam material. The IIC horizon is mixed calcareous very gravelly sand, coarse sand, or sand and gravel. Depth to the IIC material ranges from 20 to 40 inches.

Stady soils are associated in the landscape with Bowdle, Wabek, Ruso, and Manning soils. They are deeper over the coarse material and have a B2 horizon that Wabek soils lack. Stady soils contain less sand in the solum and have more clay in the B2 horizon than Ruso and Manning soils. They have a thinner A horizon than Bowdle soils.

Straw Series

The Straw series consists of deep, level, well drained loams on terraces and flood plains of small streams. These soils formed in alluvium.

In a representative profile the surface layer is dark grayish brown loam about 7 inches thick. The subsoil is dark grayish brown and grayish brown, very friable loam about 11 inches thick. The underlying material is light brownish gray and grayish brown loam, silty clay loam, and clay loam.

Permeability is moderate. Available water capacity, organic-matter content, and natural fertility are high.

Most of these soils are used for hay and pasture. Some areas are used for crops.

Representative profile of Straw loam in cropland 1,400 feet west and 30 feet south of northeast corner sec. 19, T. 148 N., R. 85 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; slightly acid; abrupt boundary.

B21—7 to 11 inches; dark grayish brown (10YR 4/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate medium subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; few fine pores; neutral; clear boundary.

B22—11 to 18 inches; grayish brown (10YR 5/2) loam, very dark grayish brown (10YR 3/2) when moist; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; common fine pores; strong effervescence; mildly alkaline; clear boundary.

C1—18 to 23 inches; light brownish gray (2.5Y 6/2) silty clay loam, dark grayish brown (2.5Y 4/2) when moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and slightly plastic; many fine roots; common fine pores; strong effervescence; moderately alkaline; clear boundary.

C2—23 to 28 inches; grayish brown (2.5Y 5/2) silty clay loam, very dark grayish brown (2.5Y 3/2) when moist; weak medium prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and slightly plastic; many fine roots; many fine pores; few fine threads and soft masses of lime; strong effervescence; strongly alkaline; gradual boundary.

C3—28 to 34 inches; grayish brown (2.5Y 5/2) loam, dark grayish brown (2.5Y 4/2) when moist; massive; hard, very friable, slightly sticky and slightly plastic; common fine roots; common fine pores; few soft masses of lime; few masses of salts and gypsum; strong effervescence; very strongly alkaline; gradual boundary.

C4—34 to 37 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; massive; hard, friable, sticky and plastic; few fine roots; few fine pores; few masses of salt and gypsum; strong effervescence; strongly alkaline; gradual boundary.

C5—37 to 60 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) when moist; massive; hard, very friable, slightly sticky and slightly plastic; few fine roots; few fine pores; strong effervescence; strongly alkaline.

The A horizon is 3 to 12 inches thick and is dark gray or dark grayish brown. The B horizon is 10 to 25 inches thick and typically ranges from dark gray to grayish brown. Depth to carbonates ranges from 5 to 24 inches. In most areas the C horizon is loam with few to many stratifications of fine sandy loam, silt loam, or clay loam. There are few or common bands of darker colored materials in the profile and few to common threads and masses of lime in this horizon.

Straw soils are associated in the landscape with Farnuf soils. In contrast, they do not have a clay accumulation in the B horizon.

St—Straw loam. This level soil is on terraces and flood plains of small streams. Slopes are 0 to 1 percent. This soil has the profile described as representative of the series. Included in mapping were small areas that have slight and moderate salinity.

This soil is well drained but has slow runoff. It is slightly susceptible to erosion.

About two-thirds of the acreage is used for hay and pasture. Some areas are used for crops. The main management need on cropland is conserving moisture and

maintaining fertility and tilth. Capability unit IIc–6; Silty range site.

Sx—Straw soils, channeled. This level mapping unit is on flood plains of small streams. It has been dissected by steep-sided stream channels that cut the landscape into small patches. The unit is mostly Straw soils, but in some areas, there are soils with a thinner, dark colored surface layer. The Straw soils have a profile similar to the one described as representative of the series, but the surface layer ranges from fine sandy loam to clay loam. Included in mapping were areas of Arnegard, Havrelon, Trembles, Parshall, and Farnuf soils. Also included were a few moderately saline areas.

This unit is well drained but has slow runoff. It is subject to flooding from high intensity rainstorms. It is highly susceptible to erosion.

This unit is not suited to crops, because it is dissected into small patches that are considered uneconomical to farm with common machinery. Nearly all the acreage is in range. Capability unit VIe–Ov; Overflow range site.

Tansem Series

The Tansem series consists of deep, gently sloping and moderately sloping, well drained soils. These soils formed in glacial lake and outwash deposits.

In a representative profile the surface layer is dark grayish brown loam about 7 inches thick. The subsoil is very friable loam about 9 inches thick. It is brown in the upper 5 inches and light olive brown in the lower 4 inches. The underlying material is light gray, white, pale yellow, and light yellowish brown loam, fine sandy loam, silt loam, very fine sandy loam, and very fine sand.

These soils have medium runoff. Permeability and organic-matter content are moderate. Natural fertility is medium.

Nearly all the acreage is cultivated and used for small grain, corn, and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Tansem loam in an area of Roseglen-Tansem complex, 3 to 6 percent slopes, in cultivated field 1,320 feet east and 175 feet north of southwest corner sec. 13, T. 146 N., R. 83 W.

Ap—0 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; hard, very friable, slightly sticky and slightly plastic; many fine roots; many fine pores; neutral; abrupt smooth boundary.

B21—7 to 12 inches; brown (10YR 4/3) loam, dark brown (10YR 3/3) when moist; ped faces coated with dark grayish brown (10YR 4/2) stains; moderate medium prismatic structure parting to moderate medium subangular blocky; hard, very friable, slightly sticky and slightly plastic; common fine roots, common fine and few medium tubular pores; neutral; clear wavy boundary.

B22—12 to 16 inches; light olive brown (2.5Y 5/3) loam, olive brown (2.5Y 4/3) when moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common roots; common pores; clear wavy boundary.

C1ca—16 to 20 inches; light gray and white (2.5Y 7/2 and 8/2) loam, light olive brown (2.5Y 5/3) when moist; weak coarse prismatic structure; hard, very friable, slightly sticky and slightly plastic; few roots; common fine pores; many large soft masses of lime; violent effervescence; moderately alkaline; clear wavy boundary.

C2ca—20 to 32 inches; pale yellow (2.5Y 7/3) loam and fine sandy loam, light olive brown (2.5Y 5/3) when moist; weak coarse subangular blocky structure; slightly hard, very friable, slightly sticky and slightly plastic; few roots; common fine pores; common medium soft masses of lime; violent effervescence; moderately alkaline; gradual wavy boundary.

C3—32 to 45 inches; light yellowish brown (2.5Y 6/4) laminated silt loam and very fine sandy loam, olive brown (2.5Y 4/4) when moist; few fine prominent dark yellowish brown (10YR 4/4) moist and few faint gray (5Y 5/1) moist mottles; massive; slightly hard, very friable, slightly sticky and slightly plastic; few fine pores; few fine soft masses of lime; strong effervescence; moderately alkaline; gradual boundary.

C4—45 to 60 inches; light yellowish brown (2.5Y 6/4) laminated silt, very fine sand, and loam, olive brown (2.5Y 4/4) when moist; gray (5Y 5/1) moist and yellowish brown (10YR 5/4) moist mottles on some of the thin layers; massive; hard, friable, slightly sticky and slightly plastic; few soft masses of lime; strong effervescence; moderately alkaline.

The solum is 14 to 20 inches thick. The A horizon is 5 to 10 inches thick and is dark grayish brown or grayish brown. The B2 horizon ranges from dark grayish brown to light yellowish brown. The C horizon is calcareous, stratified loam, silt loam, and fine sandy loam. There are threads and soft masses of lime in most profiles. The lower C horizon is stratified or varved and commonly contains mottles.

Tansem soils are associated in the landscape with Roseglen and Williams soils. They have a thinner B horizon than Roseglen soils. In contrast with Williams soils, they lack the clay accumulation in the B2 horizon.

Telfer Series

The Telfer series consists of deep, undulating and gently rolling, excessively drained soils. These soils are on hummocky, dunelike, or hilly areas. They formed in deep sandy material on uplands.

In a representative profile the surface layer is dark grayish brown loamy fine sand about 5 inches thick.

The underlying material is grayish brown and light brownish gray loamy fine sand and fine sand.

Permeability is rapid. Organic-matter content is moderate. Available water capacity and natural fertility are low.

Nearly all the acreage is used for native range. The native vegetation is mid and short prairie grasses.

Representative profile of Telfer loamy fine sand in grassy area of Telfer-Lihen loamy fine sands, 3 to 9 percent slopes, 2,340 feet south and 600 feet west of northeast corner sec. 13, T. 145 N., R. 84 W.

A1—0 to 5 inches; dark grayish brown (10YR 4/2) loamy fine sand, very dark brown (10YR 2/2) when moist; weak fine granular structure; soft, very friable, nonsticky and nonplastic; many roots; medium acid; clear boundary.

AC—5 to 15 inches; grayish brown (10YR 5/2) loamy fine sand, very dark grayish brown (10YR 3/2) when moist; single grained; loose, very friable, nonsticky and nonplastic; common roots; slightly acid; gradual boundary.

C1—15 to 35 inches; grayish brown (2.5Y 5/2) fine sand, dark grayish brown (2.5Y 4/2) when moist; single grained; loose, nonsticky and nonplastic; few roots; neutral; gradual boundary.

C2—35 to 60 inches; light brownish gray (2.5Y 6/2) fine sand, olive brown (2.5Y 4/3) when moist; single grained; loose, nonsticky and nonplastic; neutral.

The A horizon is 5 to 8 inches thick and is very dark grayish brown to grayish brown. The AC horizon is very weakly developed. It is dark grayish brown or grayish brown loamy fine sand, loamy sand, or fine sand 3 to 10 inches thick. The underlying material ranges from loamy fine sand to fine sand. The depth to carbonates ranges from 40 to more than 60 inches.

Telfer soils are associated in the landscape with the Seroco and Lihen soils. They have a thicker A horizon than Seroco soils and a thinner A horizon than Lihen soils.

TlC—Telfer-Lihen loamy fine sands, 3 to 9 percent slopes. This undulating and gently rolling mapping unit is on uplands and terraces. It is about 70 percent Telfer loamy fine sand on slopes and convex ridges, about 25 percent Lihen loamy fine sand in concave areas, and about 5 percent Seroco fine sand on some of the convex ridges. The Telfer soil has the profile described as representative of the Telfer series. Included in mapping were a few areas of Parshall fine sandy loam and Flaxton loamy fine sand.

This unit is excessively drained and has slow runoff. It is droughty and is highly susceptible to erosion.

This unit is not suited to crops. Nearly all the acreage is used for native range and pasture. A few areas are cropped but should be seeded to grass. Management is needed to maintain a good stand of grass. Capability unit VIe–Sa; Sands range site.

Temvik Series

The Temvik series consists of deep, gently to moderately sloping, well drained soils. These soils formed in a silty loess mantle 20 to 40 inches thick overlying loamy glacial till.

In a representative profile the surface layer is dark grayish brown silt loam about 8 inches thick. The subsoil is very friable silt loam about 18 inches thick. It is grayish brown in the upper 6 inches and pale brown in the lower 12 inches. The underlying material is light brownish gray and pale olive clay loam.

These soils have medium runoff. Permeability is moderate in the subsoil and moderately slow in the underlying material. Available water capacity is high. Organic-matter content is moderate. Natural fertility is medium.

Nearly all these soils are cultivated and used for small grain, corn, and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Temvik silt loam in cultivated area of Wilton-Temvik silt loams, 3 to 6 percent slopes, 375 feet north and 150 feet west of southeast corner sec. 31, T. 147 N., R. 83 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; slightly acid; abrupt smooth boundary.

B2—8 to 14 inches; grayish brown (10YR 5/2) silt loam, very dark brown (10YR 3/2) when moist; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; common fine pores; neutral; clear wavy boundary.

B3ca—14 to 26 inches; pale brown (10YR 6/3) silt loam, brown (10YR 4/3) when moist; weak medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; many fine pores; very few soft masses of lime; strong effervescence; mildly alkaline; abrupt wavy boundary.

IIC1ca—26 to 39 inches; light brownish gray (2.5Y 6/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; few fine distinct brown (7.5Y 5/4) mottles; weak coarse prismatic structure parting to weak coarse subangular blocky; hard, firm, sticky and plastic; common fine roots; common fine pores; about 2 percent fine pebbles and shale fragments; common seams and soft masses of lime; violent effervescence; mildly alkaline; gradual boundary.

IIC2—39 to 60 inches; pale olive (5Y 6/3) clay loam, olive (5Y 4/3) when moist; few fine distinct brown (7.5Y 5/4) mottles; massive; hard, firm, sticky and plastic; few fine roots; common fine pores; about 2 percent fine pebbles and shale fragments; few soft masses of lime; strong effervescence; moderately alkaline.

The A horizon is 4 to 10 inches thick and ranges

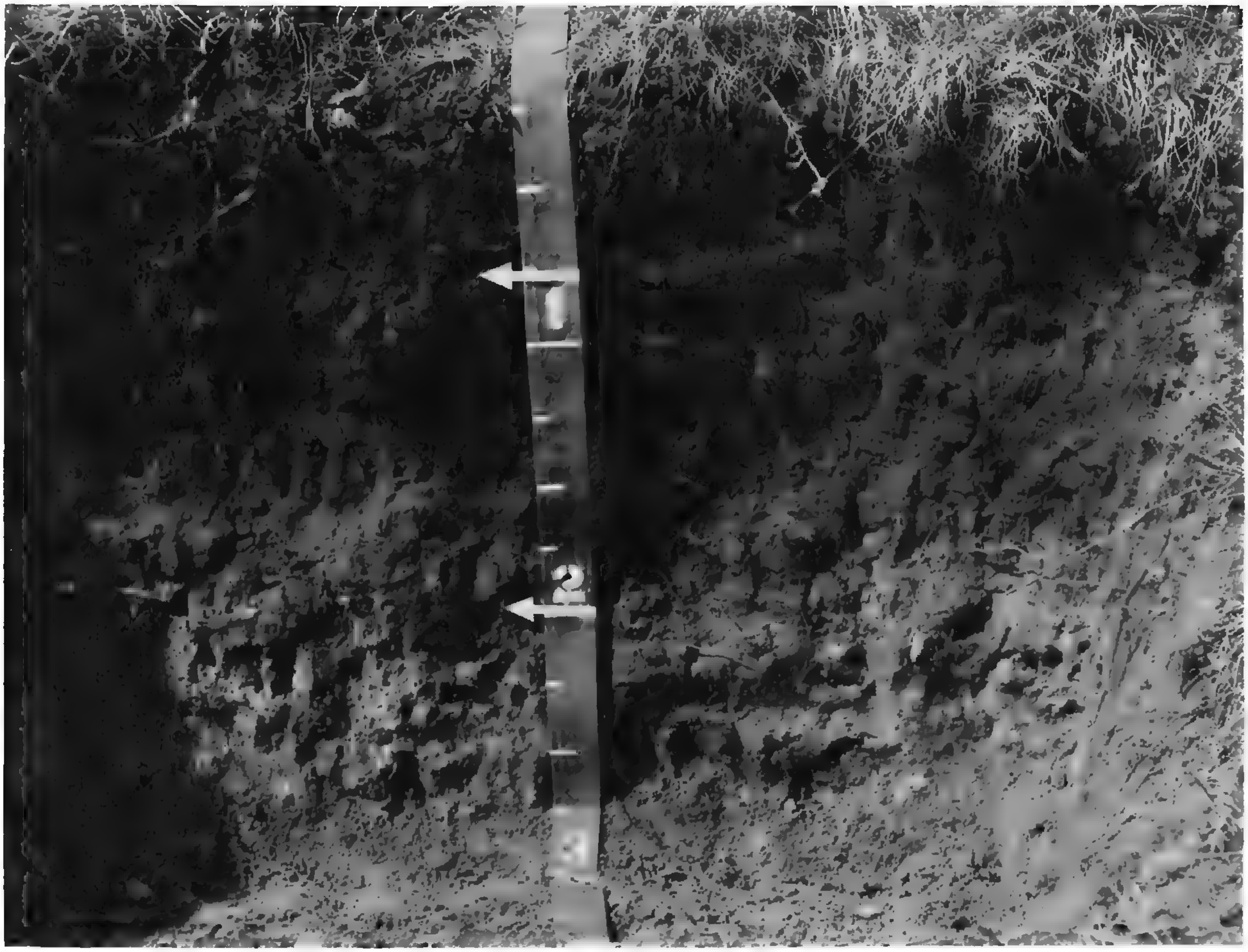

Figure 11.—**Profile of Temvik silt loam showing glacial till at 24 inches.**

from very dark grayish brown to grayish brown. The B2 horizon is 6 to 18 inches thick and ranges from dark grayish brown to brown. The B3 horizon, if present, is as much as 12 inches thick. In some pedons it is calcareous in the lower part, and in others it is calcareous throughout. The IIC horizon has few to many segregations of lime. It is multicolored glacial till with clay loam or loam. The depth to the IIC horizon ranges from 20 to 40 inches but commonly is 20 to 28 inches (fig. 11).

Temvik soils are associated with Wilton, Grassna, Linton, Mandan, and Williams soils. They have a thinner dark colored A horizon and lime accumulation at shallower depths than Wilton soils. Temvik soils have a IIC horizon of glacial till that Grassna, Linton, and Mandan soils do not have. They are less clayey and more silty in the B horizon than Williams soils, and they have a thinner A horizon than Grassna soils.

Tonka Series

The Tonka series consists of deep, level, poorly drained silt loams. These soils occur as shallow depressions on glacial till plains and lake plains. They formed in local alluvium and deposits left by glacial melt water.

In a representative profile the surface layer is dark gray silt loam about 7 inches thick. The subsurface layer is light gray silt loam about 4 inches thick. The subsoil is about 15 inches thick. It is dark gray, very firm silty clay in the upper 6 inches and grayish brown clay loam in the lower 9 inches. The underlying material is mottled light olive gray clay loam.

Permeability is slow. Available water capacity, organic-matter content, and natural fertility are high. These soils are ponded after heavy rainfall and rapid snowmelt.

Much of the acreage is cultivated and is used for small grain and alfalfa. The native vegetation is prairie cordgrass, northern reedgrass, sedges, and other plants that thrive on overflow and wetness.

Representative profile of Tonka silt loam in cultivated area of Tonka-Parnell complex, 2,240 feet north and 1,920 feet west of southwest corner sec. 13, T. 149 N., R. 85 W.

Ap—0 to 7 inches; dark gray (10YR 4/1) silt loam, black (10YR 2/1) when moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; neutral; abrupt boundary.

A2—7 to 11 inches; light gray (10YR 7/1) silt loam, dark gray (10YR 4/1) when moist; few fine distinct brown (10YR 5/3) mottles; moderate fine platy structure; slightly hard, very friable, slightly sticky and nonplastic; slightly acid; abrupt boundary.

B21t—11 to 17 inches; dark gray (10YR 4/1) silty clay, black (10YR 2/1) when moist; strong medium prismatic structure parting to moderate medium blocky; very hard, very firm, sticky and plastic; common pressure faces; slightly acid; gradual boundary.

B22t—17 to 26 inches; grayish brown (2.5Y 5/2) heavy clay loam, dark grayish brown (2.5Y 4/2) when moist; many medium distinct very dark gray and yellowish brown (10YR 3/1 and 5/4) mottles; weak medium prismatic structure parting to moderate medium blocky; very hard, very firm, sticky and plastic; slightly acid; gradual boundary.

C1g—26 to 35 inches; light olive gray (5Y 6/2) clay loam, olive gray (5Y 5/2) when moist; common medium distinct yellowish brown (10YR 5/4) mottles; massive; hard, firm, sticky and plastic; slight effervescence; neutral; clear boundary.

C2gca—35 to 45 inches; light olive gray (5Y 6/2) clay loam, olive gray (5Y 5/2) when moist; common medium distinct yellowish brown (10YR 5/4) mottles; massive; hard, firm, sticky and plastic; few threads of lime; strong effervescence; mildly alkaline; gradual boundary.

C3gca—45 to 60 inches; light olive gray (5Y 6/2) clay loam, olive gray (5Y 5/2) when moist; common large prominent white (10YR 8/1) and common fine faint dark yellowish brown (10YR 4/4) mottles; massive; hard, firm, sticky and plastic; many threads and few soft masses of lime; strong effervescence; mildly alkaline.

The Ap horizon is 6 to 18 inches thick. The A2 horizon is 4 to 10 inches thick and is typically light gray with few to many brown or yellowish brown mottles. It is silt loam, very fine sandy loam, or loam. The B horizon ranges from very dark gray to grayish brown and is 8 to 20 inches thick. It ranges from silty clay loam to clay and is 35 to 45 percent clay. The C horizon is loamy glacial till, local alluvium, or glacial melt water. The depth to lime is commonly the base of the B horizon but ranges from 20 to 60 inches.

Tonka soils are associated in the landscape with Parnell, Williams, Hamerly, and Bowbells soils. They are better drained than Parnell soils and are wetter than Williams, Hamerly, and Bowbells soils.

Tp—Tonka-Parnell complex. This level mapping unit is in shallow depressions on glacial till plains and lake plains. It is about 75 percent Tonka silt loam and 25 percent Parnell silty clay loam. Slopes are 0 to 1 percent. The Parnell soil is in the deeper parts of the depression that holds water for a longer time. It is slightly less wet than is typical of Parnell soils. Included in mapping were small areas of Bowbells, Hamerly, and Colvin soils.

This unit receives runoff from higher areas and is occasionally ponded. Much of the acreage is used for crops. Drained areas are suited to all crops commonly grown in the county. Undrained areas are frequently too wet to be planted early in spring. They are used for late crops of small grain, flax, or forage crops. In some years the soils are left idle because of wetness. Areas that are not cultivated are usually cut for hay. Capability unit IIw-6; Tonka soil in Wet Meadow range site; Parnell soil in Wetland range site.

Trembles Series

The Trembles series consists of deep, level, well drained soils on bottom land and low terraces. These soils formed in stratified alluvium.

In a representative profile the surface layer is grayish brown fine sandy loam about 4 inches thick. The underlying material is light brownish gray fine sandy loam, loam, and loamy fine sand.

Permeability is moderately rapid. Available water capacity is moderate. Organic-matter content is low. Natural fertility is medium.

Nearly all the acreage is cultivated and used for small grain, corn, and alfalfa. The native vegetation is mixed prairie grasses, shrubs, and trees.

Representative profile of Trembles fine sandy loam in pasture 1,150 feet south and 50 feet west of northeast corner of sec. 17, T. 144 N., R. 82 W.

A1—0 to 4 inches; grayish brown (2.5Y 5/2) fine sandy loam, very dark grayish brown (2.5Y 3/2) when moist; moderate fine granular structure; soft, very friable, nonsticky and nonplastic; strong effervescence; neutral; abrupt boundary.

C1—4 to 23 inches; light brownish gray (2.5Y 6/2) fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; massive and stratified; soft, very friable, nonsticky and nonplastic; several 10 millimeter strata of loamy fine sand and loam; strong effervescence; neutral; abrupt boundary.

C2—23 to 30 inches; light brownish gray (2.5Y 6/2) loam, dark grayish brown (2.5Y 4/2) when moist; massive and stratified; slightly hard, very friable, slightly sticky and slightly plastic; strong effer-

vescence; mildly alkaline; abrupt boundary.

C3—30 to 46 inches; light brownish gray (2.5Y 6/2) fine sandy loam, dark grayish brown (2.5Y 4/2) when moist; massive and stratified; soft, very friable, nonsticky and nonplastic; several 3 to 5 millimeter stratifications of loam and loamy fine sand; strong effervescence; mildly alkaline; abrupt boundary.

C4—46 to 60 inches; light brownish gray (2.5Y 6/2) loamy fine sand, grayish brown (2.5Y 5/2) when moist; single grained; loose, very friable, nonsticky and nonplastic; strong effervescence; mildly alkaline.

The A horizon is 2 to 7 inches thick and is a grayish brown or light brownish gray. It ranges from clay loam to loamy fine sand but is dominantly fine sandy loam. The C horizon is light brownish gray, light yellowish brown, and light gray fine sandy loam and loamy fine sand with thin strata of finer and coarser textures. In most areas the soil is calcareous throughout, but the upper 4 to 6 inches is noncalcareous in some profiles.

Trembles soils are associated in the landscape with Banks and Havrelon soils. They are less sandy than Banks soil and less clayey than Havrelon soils.

Tr—Trembles fine sandy loam. This level soil is on low terraces and bottom land. It occurs as narrow stringers and as irregularly shaped areas. Slopes are 0 to 1 percent. Included in mapping were small areas of Banks loamy fine sand and Havrelon loam. Also included were several areas, 10 to 40 acres in size, of a Trembles soil that has a loam surface layer.

This soil is well drained. It has slow runoff but is moderately susceptible to erosion. It is subject to flooding when ice jams occur in spring. At other times it is protected by the Garrison Dam.

This soil is suited to all crops commonly grown in the county, including irrigated crops. Nearly all the acreage is cropped. The rest is used for native range or pasture. The main management needs are controlling soil blowing, conserving moisture, and maintaining fertility and tilth. Capability unit IIIe–3; range site not assigned.

Vebar Series

The Vebar series consists of moderately deep, gently sloping and moderately sloping, well drained fine sandy loams. These soils are on uplands and are weathered from sandstone.

In a representative profile the surface layer is dark grayish brown fine sandy loam about 7 inches thick. The subsoil is dark grayish brown and grayish brown, very friable fine sandy loam about 8 inches thick. The underlying material is light gray sandy loam. Sandstone is at 38 inches.

Permeability is moderately rapid. Available water capacity and organic-matter content are moderate. Natural fertility is medium.

Representative profile of Vebar fine sandy loam in grassy area of Vebar-Williams fine sandy loams, 3 to 9 percent slopes, 2,250 feet east and 40 feet north of southwest corner sec. T. 150 N., R. 89 W.

A1—0 to 7 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark brown (10YR 2/2) when moist; moderate medium granular structure; soft, very friable, nonsticky and nonplastic; many roots; neutral; clear smooth boundary.

B21—7 to 12 inches; dark grayish brown (10YR 4/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak coarse prismatic structure parting to weak medium subangular blocky; soft, very friable, nonsticky and nonplastic; many roots; neutral; gradual wavy boundary.

B22—12 to 15 inches; grayish brown (10YR 5/2) fine sandy loam, very dark grayish brown (10YR 3/2) when moist; weak medium prismatic structure parting to weak medium subangular blocky; soft, very friable, nonsticky and nonplastic; few roots; neutral; abrupt smooth boundary.

C1—15 to 38 inches; light gray (2.5Y 7/2) sandy loam, grayish brown (2.5Y 5/2) when moist; massive; loose, nonsticky and nonplastic; few roots; strong effervescence; mildly alkaline; diffuse wavy boundary.

C2—38 to 60 inches; light olive gray (5Y 6/2) soft sandstone that crushes to loamy fine sand. olive gray (5Y 5/2) when moist; massive; strong effervescence; mildly alkaline.

The A horizon is 5 to 9 inches thick. The B horizon ranges from dark grayish brown to brown or pale brown. The C1 horizon is mostly sandy loam, but is fine sandy loam and loamy fine sand in places. The depth to carbonates ranges from 12 to 30 inches. Segregated lime that ranges from very few to common threads and soft masses occur in some pedons. The C horizon grades into soft sandstone between 20 and 40 inches.

Vebar soils are associated in the landscape with Flasher, Cohagen, Arnegard, Parshall, and Williams soils. They are deeper than Flasher and Cohagen soils but are less deep than Arnegard, Parshall, and Williams soils.

VwC—Vebar-Williams fine sandy loams, 3 to 9 percent slopes. This gently and moderately sloping mapping unit is on uplands. It is about 50 percent Vebar soil, 30 percent Williams soil, and about 20 percent Parshall soil. The Vebar soil has the profile described as representative of the series. It is on plane and convex upper slopes. The Williams soil is on plane and concave lower slopes. The Parshall soil is gently sloping and in swales. Included with these soils in mapping were small areas of Cohagen, Flaxton, Flasher, Max, Arnegard, and Zahl soils.

This unit is well drained. It has medium runoff and is moderately susceptible to erosion.

About half the acreage is cropped. The rest is used for native range or pasture. The soils are suited to all crops commonly grown in the county. Controlling

erosion is an essential part of management. Conserving moisture and maintaining fertility and tilth are also necessary. Capability unit IVe–3; Vebar soil in Sandy range site; Williams soil in Silty range site.

Wabek Series

The Wabek series consists of nearly level to rolling, excessively drained soils that are very shallow over sand and gravel. These soils formed in outwash.

In a representative profile the surface layer is dark grayish brown loam about 7 inches thick. The underlying material is light brownish gray gravelly sandy loam and very gravelly coarse sand.

Permeability is moderately rapid in the surface layer and very rapid in the underlying material. Available water capacity is very low. Organic-matter content is moderate. Natural fertility is low.

Most of the acreage is in native vegetation of mid and short prairie grasses.

Representative profile of Wabek loam in area of Wabek soils, 1 to 6 percent slopes, in native vegetation 2,685 feet east and 70 feet south of northwest corner of sec. 23, T. 145 N., R. 79 W.

A1—0 to 7 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard, very friable, nonsticky and nonplastic; many fine pebbles; slight effervescence; mildly alkaline; clear boundary.

IIC1ca—7 to 13 inches; light brownish gray (2.5Y 6/2) gravelly sandy loam, dark grayish brown (2.5Y 4/2) when moist; massive; loose, nonsticky and nonplastic; common soft masses of lime; violent effervescence; mildly alkaline; gradual boundary.

IIC2—13 to 60 inches; light brownish gray (2.5Y 6/2) very gravelly coarse sand, dark grayish brown (2.5Y 4/2) when moist; single grained; loose, nonsticky and nonplastic; lime pendants on underside of gravel; violent effervescence; mildly alkaline.

The solum is 6 to 14 inches thick. The A horizon is 3 to 7 inches thick and is dark gray to very dark brown. It ranges from gravelly sandy loam to loam or gravelly loam.

The IIC1ca horizon is typically gravelly loam or gravelly sandy loam 4 to 8 inches thick. It ranges from coarse sand to very gravelly loamy sand or a mixture of sand and gravel. Crusts of lime are on the underside of the pebbles in the upper part.

Wabek soils are associated in the landscape with Ruso, Manning, Bowdle, Stady, Max, and Zahl soils. They are shallower over sand and gravel than Ruso, Manning, Bowdle, and Stady soils. They differ from Max and Zahl soils in having a IIC horizon.

WaB—Wabek-Max-Zahl loams, 1 to 6 percent slopes. This nearly level and undulating mapping unit is on outwash mantled areas of glacial till plains. Thickness of the gravelly mantle ranges from 1 inch to several feet. Scattered gravel, cobbles, and stones are on the surface.

This unit is about 50 percent Wabek soil, 20 percent Max loam, 20 percent Zahl loam, and 10 percent minor soils. All are intricately associated. Thickness of the profile varies greatly within short distances. Included in mapping were small areas of Williams, Stady, Manning, Bowdle, and Ruso soils.

This unit is excessively drained and well drained. Runoff is slow. Nearly all the acreage is in native range and pasture. Management is needed to maintain good stands of native grasses. Capability unit VIe–TU; Wabek soil in Very Shallow range site, Max soil in Silty range site, Zahl soil in Thin Upland range site.

WaD—Wabek-Max-Zahl loams, 6 to 15 percent slopes. This gently rolling and rolling mapping unit is on outwash mantled areas of glacial till plains. Thickness of the gravelly mantle ranges from 1 inch to several feet. Scattered gravel, cobbles, and stones are on the surface.

This mapping unit is about 50 percent Wabek soil, 20 percent Max loam, 20 percent Zahl loam, and 10 percent minor soils. All are closely associated. Thickness of the profile ranges greatly within short distances. Included in mapping were small areas of Williams, Stady, Manning, Bowdle, and Ruso soils.

This unit is excessively drained and well drained. Runoff is slow. Nearly all of the acreage is in native range and pasture. Management is needed to maintain good stands of native grasses. Capability unit VIe–TU; Wabek soil in Very Shallow range site, Max soil in Silty range site, Zahl soil in Thin Upland range site.

WbB—Wabek soils, 1 to 6 percent slopes. These nearly level and undulating soils occupy ridges and knolls on terraces and glacial outwash plains. The surface layer ranges from loam to gravelly sandy loam. The profile is the one described as representative of the series (fig. 12). Areas are convex and concave. The concave areas are generally the deeper soils. Depth to loose sand and gravel varies greatly over short distances. Included in mapping were areas of Stady, Manning, Bowdle, Ruso, and other soils.

These soils are excessively drained. Runoff is slow. Most of the acreage is in native range and pasture. A few areas in fields of better soils have been farmed. These areas should be seeded to grass and well managed. Capability unit VIs–VS; Very Shallow range site.

WbD—Wabek soils, 6 to 15 percent slopes. These gently rolling and rolling soils occupy ridges and knolls on outwash plains and terraces. They are intermingled with deeper soils on the landscape. The surface layer ranges from loam to gravelly sandy loam. Depth to loose sand and gravel varies greatly over short distances. Included in mapping were areas of Stady, Manning, Bowdle, Ruso, and other soils. Also included were some areas where slopes are steeper than 15 percent.

These soils are excessively drained. Runoff is slow. Nearly all the acreage is in native range and pasture. Management is needed to maintain good stands of native grasses. Capability unit VIs–VS; Very Shallow range site.

Williams Series

The Williams series consists of deep, nearly level to gently rolling, well drained soils. These soils formed in loamy glacial till.

Figure 12.—Profile of Wabek loam showing gravel at a depth of 7 inches.

In a representative profile the surface layer is dark grayish brown loam about 5 inches thick. The subsoil is friable clay loam about 11 inches thick. It is brown in the upper 7 inches and grayish brown in the lower 4 inches. The underlying material is light brownish gray and light olive brown clay loam.

Permeability is moderate in the subsoil and moderately slow in the underlying material. Available water capacity and natural fertility are high. Organic-matter content is moderate.

Nearly all the acreage is cultivated and used for small grain, corn, and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Williams loam in cultivated area of Williams-Bowbells loams, 1 to 3 percent slopes, 2,310 feet east and 2,020 feet north of southeast corner sec. 17, T. 146 N., R. 81 W.

Ap—0 to 5 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard, friable, slightly sticky and slightly plastic; few pebbles; abrupt smooth boundary.

B2t—5 to 12 inches; brown (10YR 4/3) clay loam, dark brown (10YR 3/3) moist; peds coated with dark grayish brown (10YR 4/2) and very dark grayish brown (10YR 3/2) when moist; moderate medium prismatic structure parting to moderate medium angular blocky; hard, friable, sticky and plastic; common fine roots; few fine pores; continuous clay films on ped faces; few pebbles; clear smooth boundary.

B3ca—12 to 16 inches; grayish brown (2.5Y 5/2) clay loam, dark grayish brown (2.5Y 4/2) when moist; peds coated with patches of dark grayish brown (2.5Y 4/2) and very dark grayish brown (2.5Y 3/2) moist; moderate medium prismatic structure parting to weak medium subangular blocky; hard, friable, sticky and slightly plastic; common fine roots; few fine pores; patches of clay films on ped faces; about 5 percent fine gravel; few seams and soft masses of lime; strong effervescence; clear wavy boundary.

C1ca—16 to 26 inches; light brownish gray (2.5Y 6/2) light clay loam, light olive brown (2.5Y 5/3) when moist; white (2.5Y 8/2) and light gray (2.5Y 7/2) moist on lime patches; moderate coarse prismatic structure parting to weak coarse subangular blocky; hard, friable, sticky and slightly plastic; common fine roots; common fine pores; about 5 percent fine gravel; common and soft masses of lime; strong effervescence; gradual wavy boundary.

C2—26 to 40 inches; light brownish gray (2.5Y 6/2) light clay loam, grayish brown (2.5Y 5/2) when moist; weak very coarse prismatic structure; hard, friable, sticky and slightly plastic; few fine roots; few fine pores; about 5 percent fine gravel; few seams and soft masses of lime; strong effervescence; diffuse boundary.

C3—40 to 60 inches; light olive brown (2.5Y 5/3) clay loam, olive brown (2.5Y 4/3) when moist; common medium distinct light yellowish brown (10YR 6/4) and gray (5Y 6/1) moist mottles; massive; very hard, firm, sticky and plastic; few fine roots; few medium pores; about 5 percent gravel; few seams and soft masses of lime; strong effervescence.

The A horizon is very dark grayish brown to grayish brown 5 to 12 inches thick. It is dominantly loam, silt loam or clay loam, but some is fine sandy loam. The B2 horizon is clay loam or heavy loam 5 to 16 inches thick and ranges from brown to dark grayish brown. Clay films are common on vertical and horizontal ped faces, although they are only on vertical surfaces in some profiles. The Cca horizon has disseminated lime throughout and contains few to common soft masses and threads of lime. The C horizon is multicolored glacial till and is clay loam or heavy

loam. Coarse fragments ranging in size from gravel to stones occur throughout the profile.

Williams soils are associated in the landscape with Bowbells, Max, Zahl, Temvik, and Flaxton soils. They are better drained than Bowbells soils. They have more clay accumulation in the B horizon than Max soils. They have a B horizon that Zahl soils do not have. They lack the IIC horizon of Temvik and Flaxton soils.

WlB—Williams stony loam, 1 to 9 percent slopes. This nearly level to gently rolling, very stony soil is on glacial till uplands. It has many boulders and stones on the surface and throughout the soil, and removing them is not feasible. The surface is stony; otherwise, this soil has a profile similar to the one described as representative of the series. Included in mapping were areas of Bowbells, Max, and Zahl soils, which are also stony.

This soil is well drained. Runoff is medium.

This soil is too stony for cultivation. It is suited to grazing or wildlife. All the acreage is in native grass. The stones interfere with cutting hay. Capability unit VIIs-Si; Silty range site.

WmA—Williams clay loam, 1 to 3 percent slopes. This nearly level soil is on glacial till uplands. The surface layer is dark grayish brown clay loam 5 to 10 inches thick. The subsoil and underlying material are slightly finer textured than is described as representative of the series. Included in mapping were areas of Sinai, Makoti, Grail, Bowbells, Tonka, and Parnell soils.

This soil is well drained. It has medium runoff and is slightly susceptible to erosion.

Nearly all the acreage is used for crops. The rest is in native range or pasture. The soil is suited to all crops commonly grown in the county. The chief management needs are conserving moisture and maintaining fertility and tilth. Capability unit IIc–6; Silty range site.

WmB—Williams clay loam, 3 to 6 percent slopes. This undulating and gently sloping soil is on glacial till uplands. The surface layer is dark grayish brown clay loam 5 to 10 inches thick. The subsoil and underlying material are slightly finer textured than is described as representative of the series. Included in mapping were areas of Sinai, Makoti, Grail, Bowbells, Tonka, and Parnell soils.

This soil is well drained. It has medium runoff and is slightly susceptible to erosion.

Nearly all the acreage is used for crops. The rest is in native range or pasture. Controlling erosion, conserving moisture, and maintaining fertility and tilth are the main management needs. Capability unit IIe–6; Silty range site.

WoA—Williams-Bowbells loams, 1 to 3 percent slopes. This nearly level mapping unit is on glacial till uplands. It is about 70 percent Williams loam and 30 percent Bowbells loam. Williams soils are on the plane and slightly convex slopes. Bowbells soils are on the lower and concave parts of the landscape. These soils have the profiles described as representative of their respective series. Included in mapping were small areas of Zahl, Max, and Arnegard soils. Also included were small areas of Tonka and Parnell soils in undrained depressions.

This unit is well drained. It has medium runoff and is slightly susceptible to erosion.

Nearly all the acreage is used for crops. The rest is in native range or pasture. This unit is suited to all crops commonly grown in the county. The main management needs are conserving moisture and maintaining fertility and tilth. Capability unit IIc–6; Williams soil in Silty range site, Bowbells soil in Overflow range site.

WoB—Williams-Bowbells loams, 3 to 6 percent slopes. This undulating and gently sloping mapping unit is on glacial till uplands. It is about 60 percent Williams loam, 30 percent Bowbells loam, and 10 percent minor soils. Williams soils are on the smooth and slightly convex slopes. Bowbells soils are on the lower and concave parts of the landscape. Included in mapping were small areas of Zahl, Max, and Arnegard. Also included were small areas of Tonka and Parnell soils in undrained depressions.

This unit is well drained. It has medium runoff and is slightly susceptible to erosion.

Nearly all the acreage is used for crops. The rest is in native range or pasture. This unit is suited to all crops commonly grown in the county. Controlling erosion, conserving moisture, and maintaining fertility and tilth are the main management needs. Capability unit IIe–6; Silty range site.

WoC—Williams-Bowbells loams, 6 to 9 percent slopes. This gently rolling and moderately sloping mapping unit is on glacial till uplands. It is about 60 percent Williams loam, 30 percent Bowbells loam, and 10 percent Zahl and Max soils. The Williams soil is on the smooth side slopes. The Bowbells soil is on the lower and concave parts of the landscape. Zahl and Max soils are on steeper slopes and convex ridges. Also included were small areas of Tonka and Parnell soils in undrained depressions.

This unit is well drained. It has medium runoff and is moderately susceptible to erosion.

More than half of the acreage is cultivated. The rest is in native range or pasture. The soils are suited to all crops commonly grown in the county. Controlling erosion is an essential part of management. Contour stripcropping generally is impractical because of the short irregular slopes. Capability unit IIIe–6; Silty range site.

WpB—Williams-Bowbells-Zahl loams, 3 to 6 percent slopes. This undulating mapping unit is on glacial till uplands. It is about 40 percent Williams loam, 30 percent Bowbells loam, 25 percent Zahl loam, and 5 percent minor soils. Williams loam is on the smooth side slopes. Bowbells loam is on lower side slopes and concave parts of the landscape. Zahl loam is on the ridges and higher convex slopes. Included in mapping were small areas of Max loam and Arnegard loam. Also included were small areas of Tonka and Parnell soils in undrained depressions.

This unit is moderately well drained and well drained. It has slow runoff and is slightly susceptible to erosion.

This unit is used for crops and range. It is suited to all crops commonly grown in the county. Controlling erosion, conserving moisture, and maintaining fertility and tilth are the main management needs. Capability

unit IIe–6; Williams and Bowbells soils in Silty range site, Zahl soil in Thin Upland range site.

WrB—Williams loam, mine sink, 1 to 6 percent slopes. This nearly level and undulating soil is on glacial till uplands. Mine sinks or caved-in areas caused by underground mining are mapped with this soil. Although they vary greatly in number, they average about 30 percent of each mapped area. Included in mapping were areas of Bowbells, Max, and Zahl soils, which also contain mine sinks.

Much of this soil is used for grazing, but occasionally livestock are lost. The soil is not suited to crops or hay because of the danger of additional cave-ins. It has limited use for wildlife. Capability unit VIIs–Si; Silty range site.

Wilton Series

The Wilton series consists of deep, level to rolling, well drained soils. These soils formed in a silty loess mantle 20 to 40 inches thick over loamy glacial till.

In a representative profile the surface layer is dark grayish brown silt loam about 8 inches thick. The subsoil is very friable silt loam about 19 inches thick. It is dark grayish brown in the upper 5 inches, and grayish brown in the lower 14 inches. The underlying material is light brownish gray clay loam.

The permeability is moderate in the subsoil and moderately slow in the underlying material. Available water capacity and organic-matter content are high. Natural fertility is medium.

Nearly all these soils are cultivated and used for small grain, corn, and alfalfa. The native vegetation is mid and short prairie grasses.

Representative profile of Wilton silt loam, 0 to 3 percent slopes, in cultivated field 1,600 feet east and 300 feet north of southwest corner sec. 31, T. 147 N., R. 83 W.

Ap—0 to 8 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; common fine pores; neutral; clear wavy boundary.

B21—8 to 13 inches; dark grayish brown (10YR 4/2) silt loam, very dark brown (10YR 2/2) when moist; moderate medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; many fine roots; common fine pores; neutral; clear wavy boundary.

B22—13 to 18 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate medium prismatic structure parting to moderate medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; common fine pores; thin clay films on some vertical ped faces; very dark brown (10YR 2/2) moist coatings on peds; neutral; gradual wavy boundary.

B23—18 to 27 inches; grayish brown (10YR 5/2) silt loam, very dark grayish brown (10YR 3/2) when moist; moderate medium prismatic structure parting to weak medium subangular blocky; slightly hard, very friable, slightly sticky and slightly plastic; common fine roots; common fine pores; slight effervescence in spots; mildly alkaline; clear wavy boundary.

IIC1ca—27 to 36 inches; light brownish gray (2.5Y 6/2) light clay loam, dark grayish brown (2.5Y 4/2) when moist; weak coarse prismatic structure parting to weak coarse and medium subangular blocky; hard, friable, sticky and plastic; few fine roots; common fine pores; strong effervescence; lime segregated in many medium and few large soft masses; mildly alkaline; gradual wavy boundary.

IIC2ca—36 to 60 inches; light brownish gray (2.5Y 6/2) light clay loam, olive brown (2.5Y 4/3) when moist; few fine prominent strong brown (7.5YR 5/6) mottles; massive; hard, friable, sticky and plastic; few roots; strong effervescence; lime segregated in common soft masses; moderately alkaline.

The A horizon is 6 to 14 inches thick and ranges from very dark grayish brown to grayish brown. The B horizon is 10 to 24 inches thick and ranges from dark grayish brown to pale brown. The lower part of the B horizon is calcareous in many pedons.

The IIC horizon has few to many segregations of lime. It is glacial till of clay loam or heavy loam. The depth to a IIC horizon ranges from 20 to 40 inches, but commonly is 24 to 32 inches.

Wilton soils are associated in the landscape with Temvik, Linton, Mandan, Grassna, and Williams soils. They have a lime accumulation at greater depths than Temvik soils and have a IIC horizon that is lacking above 50 inches in Linton, Mandan, Grassna, and Williams soils.

WsA—Wilton silt loam, 1 to 3 percent slopes. This level and nearly level soil is on broad uplands. It has the profile described as representative of the series. Included in mapping were small areas of Temvik, Williams, Grassna, Linton, Mandan, and Tonka soils.

This soil is well drained but has slow runoff.

Nearly all this soil is used for crops. It is suited to all crops commonly grown in the county. The main management needs are conserving moisture and maintaining fertility and tilth. A few areas remain in native range. Capability unit IIc–6; Silty range site.

WtB—Wilton-Temvik silt loams, 3 to 6 percent slopes. This gently sloping and undulating mapping unit is on uplands. It is about 60 percent Wilton silt loam, 25 percent Temvik silt loam, and 15 percent Williams silt loam. The Wilton soil is on plane and concave slopes. The Temvik soil is on upper slopes and in slightly convex areas. It has the profile described as representative of the Temvik series. Except for a silt loam surface layer, the Williams soil has a profile similar to the one described for the Williams series. Included in mapping were small areas of Grassna, Linton, Mandan, Max, Zahl, and Tonka soils.

This unit is well drained. It has medium runoff and is slightly susceptible to erosion.

This unit is suited to all crops commonly grown in the county. Nearly all the acreage is used for crops. A few areas are in native range. Controlling erosion, conserving moisture, and maintaining fertility and tilth are the main management needs. Capability unit IIe-6; Silty range site.

WwC—Wilton-Williams silt loams, 6 to 9 percent slopes. This moderately sloping and gently rolling mapping unit is on uplands. It is about 45 percent Wilton silt loam, 25 percent Williams silt loam, 20 percent Temvik silt loam, and 10 percent Grassna silt loam. Wilton soils are on smooth or slightly concave slopes. Williams soils are on upper slopes and convex slopes. Temvik soils are on steeper plane slopes, and Grassna soils are in swales. The Williams soil has a silt loam surface layer; otherwise, its profile is similar to the one described as representative of the series. Included in mapping were a few small areas of Linton, Mandan, Arnegard, Max, Zahl, and Tonka soils.

This unit is well drained and has medium runoff. It is moderately susceptible to erosion.

This unit is suited to all crops commonly grown in the county. Nearly all the acreage is used for crops. The rest is in native range or pasture. Controlling erosion is an essential part of management. Conserving moisture and maintaining fertility and tilth are also necessary. Capability unit IIIe-6; Silty range site.

Zahl Series

The Zahl series consists of deep, nearly level to steep, well drained soils. These soils formed in loamy glacial till.

In a representative profile the surface layer is dark grayish brown loam about 6 inches thick. The underlying material is light brownish gray and light olive gray loam and clay loam.

Permeability is moderate in the upper part of the profile and moderately slow in the underlying material. Available water capacity is high. Organic-matter content is moderate. Natural fertility is low.

Nearly all the acreage is used for range and pasture, but some areas are used for crops. The native vegetation is mid and short grasses.

Representative profile of Zahl loam, 8 percent slopes, in a cultivated field 240 feet east and 1,600 feet south of the northwest corner, sec. 8, T. 149 N., R. 81 W.

Ap—0 to 6 inches; dark grayish brown (10YR 4/2) loam, very dark brown (10YR 2/2) when moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and slightly plastic; slight effervescence; abrupt smooth boundary.

C1ca—6 to 15 inches; light brownish gray (2.5Y 6/2) heavy loam, olive brown (2.5Y 4/3) when moist; common medium faint dark grayish brown (2.5Y 4/2) and olive brown (2.5Y 4/4) and many medium distinct dark gray (5Y 4/1) and dark brown (7.5Y 4/4) moist mottles; moderate medium prismatic structure parting to weak medium subangular blocky; hard, friable, slightly sticky and slightly plastic; common fine roots; common fine pores; common films and masses of lime; strong effervescence; gradual wavy boundary.

C2—15 to 26 inches; light brownish gray (2.5Y 6/2) light clay loam, light olive brown (2.5Y 5/3) when moist; common medium faint olive brown (2.5Y 4/4) and many medium distinct dark gray (5Y 4/1), dark brown (7.5Y 4/4), and dark yellowish brown (10YR 4/4) moist mottles; weak coarse prismatic structure; hard, friable, sticky and slightly plastic; common fine roots; common fine pores; few films and soft masses of lime; strong effervescence; gradual wavy boundary.

C3—26 to 42 inches; light brownish gray (2.5Y 6/2) clay loam, light olive brown (2.5Y 5/3) when moist; many large distinct dark gray (5Y 4/1), dark brown (7.5YR 4/4), and dark yellowish brown (10YR 4/4) moist mottles; moderate structure; very hard, firm, sticky and slightly plastic; few fine roots; few fine pores; strong effervescence; diffused boundary.

C4—42 to 60 inches; light olive gray (5Y 6/2) clay loam, olive (5Y 4/3) when moist; many large distinct dark gray (5Y 4/1) and dark brown (7.5YR 4/4) moist mottles; strong medium prismatic structure parting to strong medium angular blocky; very hard, firm, sticky and plastic; few roots; few pores; strong effervescence.

The A horizon is 4 to 8 inches thick. The Cca horizon is loam or clay loam and has weak to moderate structure. Soft masses of lime are common throughout the Cca horizon. The C horizon ranges from massive to weak and moderate structure.

Zahl soils are associated in the landscape with Max, Williams, and Cabba soils. Unlike Max and Williams soils, they lack a B2 horizon. They are deeper than Cabba soils.

ZcE—Zahl-Cabba complex, 15 to 35 percent slopes. This hilly and steep mapping unit is on uplands. It is about 50 percent Zahl soils, 30 percent Cabba soils, and 20 percent minor soils. The surface layer ranges from very fine sandy loam to silty clay loam. Included in mapping were small areas of Flasher, Cohagen, Max, Williams, Arnegard, Morton, Regent, Straw, and Vebar soils.

This unit is well drained and has rapid and very rapid runoff. It is highly susceptible to erosion.

This unit is used for range and pasture (fig. 13). Management is needed to maintain good stands of grass. Capability unit VIIe-TU; Zahl soil in Thin Upland range site, Cabba soil in Shallow range site.

ZmE—Zahl-Max loams, 9 to 35 percent slopes. This rolling to steep mapping unit is on uplands. It is about 50 percent Zahl loam, 30 percent Max loam, and about 20 percent Bowbells, Williams, and Arnegard soils. Zahl loam is on ridges and in higher convex areas in the landscape, Max loam is on side slopes, and Bowbells, Williams, and Arnegard soils are on concave,

Figure 13.—**Range on Zahl-Cabba complex. Zahl and Cabba soils are on the steep slopes. Arnegard and Straw soils are in the small drainageway.**

lower slopes. Included in mapping were small areas of Tonka and Parnell soils in undrained depressions.

The unit is well drained and has rapid runoff. It is highly susceptible to erosion.

Nearly all the acreage is used for native range or pasture. It is unsuited to crops. Cultivated areas should be seeded to grass. Management is needed to maintain good stands of grass. Capability unit VIe–TU; Zahl soil in Thin Upland range site, Max soil in Silty range site.

ZpE—Zahl-Max-Parnell complex, 15 to 35 percent slopes. This hilly and steep mapping unit is on uplands. It is mainly on dead-ice moraines of high relief. This unit is about 30 percent Zahl soils, 30 percent Max soils, 20 percent Parnell soils, and 20 percent Bowbells, Williams, Arnegard, and Tonka soils. The Zahl soil is on convex ridges and steep slopes. The Max soil is on the smoother sides of slopes, and the Parnell soil is in the many depressions that dot the landscape. The surface layer ranges from loam to silty clay loam.

This unit is very poorly drained to well drained. Water runs off into the numerous depressions. No streams leave the mapped areas; all rainfall stays on the land.

This unit is unsuited to crops. All areas are used for native range or pasture. Forage yields are good because of the high percentage of soils that receive beneficial run-in water. Management is needed to maintain good stands of native grasses. Capability unit VIe–TU; Zahl soil in Thin Upland range site, Max soil in Silty range site, Parnell soil in Wetland range site.

ZwC—Zahl-Williams loams, 3 to 9 percent slopes. This nearly level to gently rolling mapping unit is on uplands. It is about 75 percent Zahl loam and 25 percent Williams loam. The Zahl soil has the profile described as representative of the series and is on the convex parts of the landscape. The Williams soil is on the smoother plane and concave parts of the landscape. Included in mapping were small areas of Max, Bowbells, and Arnegard soils.

This unit is well drained. It has rapid runoff and is highly susceptible to erosion.

The acreage is used mostly for crops. The rest is in native range or pasture. Controlling erosion, conserving moisture, and maintaining fertility and tilth are the main management concerns. Capability unit

IVe–4L; Zahl soil in Thin Upland range site, Williams soil in Silty range site.

Planning the Use and Management of the Soils

The soil survey is a detailed analysis and evaluation of the most basic resource of the survey area—the soil. It may be used to fit the use of the land, including urbanization, to the limitations and potentials of the natural resources and the environment and to help avoid soil-related failures in uses of the land.

During a soil survey soil scientists, conservationists, engineers, and others keep extensive notes, not only about the nature of the soils but also about unique aspects of behavior of these soils in the field and at construction sites. These notes include observations of erosion, drought damage to specific crops, yield estimates, flooding, the functioning of septic systems, and other factors relating to the kinds of soil and their productivity, potentials, and limitations under various uses and management. In this way field experience incorporated with measured data on soil properties and performance is used as a basis for predicting soil behavior.

Information in this section will be useful in applying basic facts about the soils to plans and decisions for use and management of soils for crops and pasture, range, woodland, and many nonfarm uses, including building sites, highways and other transportation systems, sanitary facilities, parks and other recreational developments, and wildlife habitat. From the data presented, the potential of each soil for specified land uses may be determined, soil limitations to these land uses may be identified, and costly failures in homes and other structures, because of unfavorable soil properties, may be avoided. A site can be selected where the soil properties are favorable, or practices can be planned that will overcome the soil limitations.

Planners and others using the soil survey can evaluate the impact of specific land uses on the overall productivity of the survey area or other broad planning area, and on the environment. Both of these factors are closely related to the nature of the soil. Plans can be made to maintain or create a land use pattern in harmony with the natural soil.

Contractors can find information useful in locating sources of sand and gravel, road fill, and topsoil. Other information indicates the presence of bedrock, wetness, or very firm soil horizons that cause difficulty in excavation.

Health officials, highway officials, engineers, and many other specialists can find useful information in this soil survey. The safe disposal of wastes, for example, is closely related to properties of the soil. Pavements, sidewalks, campsites, playgrounds, lawns, trees, and shrubs, and most other uses of land are influenced by the nature of the soil.

General Management of Cropland [2]

About 73 percent of the survey area is cultivated. Spring wheat and Durum wheat are the principal crops. Other important crops are barley, oats, flax, alfalfa, and corn for silage.

The main management concerns for cultivated soils are conserving moisture, controlling soil blowing and water erosion, and maintaining fertility and organic-matter content.

In dryfarmed areas, conserving moisture generally means reducing evaporation, limiting runoff, increasing infiltration, and controlling weeds. Some effective conservation measures are stubble mulching, contour farming, stripcropping, field windbreaks, buffer strips, timely tillage, minimum tillage, use of crop residue, and application of fertilizer. Fallow helps to control weeds and build up moisture content.

Some measures that help to control erosion are cover crops, stripcropping, buffer strips, windbreaks, contour farming, diversions, waterways, minimum tillage, timely tillage, emergency tillage, and use of crop residue. A combination of several measures is generally used.

The application of chemical fertilizer, green manure, and barnyard manure and the use of cover crops, grasses, and legumes as well as protective or stubble mulch summer fallow are measures that help to maintain fertility. Controlling erosion also helps conserve fertility.

Drainage, removal of stones, chiseling or deep tillage, and reduction of salinity may be needed to offset the effects of unfavorable soil characteristics.

In irrigated areas the main crops are alfalfa and corn for silage. Small grain, sugar beets, and pasture are also grown. The most common management concerns for irrigated soils are maintaining fertility and organic matter, controlling erosion, and using water efficiently.

The irrigation system is chosen to provide optimum control and distribution of water at minimum cost and labor. Overirrigation wastes water, leaches plant nutrients, and erodes the soil. Excess water also creates drainage problems, raises water tables, and increases soil salinity. On steeper slopes, the hazard of erosion is greater. Under erosion and continued deep tillage, the subsurface layer may be mixed with the plow layer. This reduces crop yields and increases cost of management.

Capability grouping

Capability grouping shows, in a general way, the suitability of soils for most kinds of field crops. The soils are grouped according to their limitations when used for field crops, the risk of damage when they are used, and the way they respond to treatment. The grouping does not take into account major and generally expensive landforming that would change slope, depth, or other characteristics of the soils; does not take into consideration possible, but unlikely, major reclamation projects; and does not apply to rice, cranberries, horticultural crops, or other crops requiring special management.

Those familiar with the capability classification can infer from it much about the behavior of soils when used for other purposes, but this classification is not a substitute for interpretations designed to show suitability and limitations of groups of soils for range, forest trees, or engineering (*8*).

[2] EDWARD R. WEIMER, agronomist, Soil Conservation Service.

In the capability system, the kinds of soil are grouped at three levels: the capability class, the subclass, and the unit. These levels are described in the following paragraphs:

CAPABILITY CLASSES, the broadest group, are designated by Roman numerals I through VIII. The numerals indicate progressively greater limitations and narrower choices for practical use, defined as follows:

- Class I soils have few limitations that restrict their use. There are no class I soils in McLean County.
- Class II soils have moderate limitations that reduce the choice of plants or that require moderate conservation practices.
- Class III soils have severe limitations that reduce the choice of plants, require special conservation practices, or both.
- Class IV soils have very severe limitations that reduce the choice of plants, require very careful management, or both.
- Class V soils are subject to little or no erosion, but have other limitations, impractical to remove, that limit their use largely to pasture or range, woodland, or wildlife habitat.
- Class VI soils have severe limitations that make them generally unsuitable for cultivation and limit their use largely to pasture or range, woodland, or wildlife habitat.
- Class VII soils have very severe limitations that make them unsuitable for cultivation and that restrict their use largely to range, woodland, or wildlife habitat.
- Class VIII soils and landforms have limitations that preclude their use for commercial crop production and restrict their use to recreation, wildlife habitat, water supply, or to esthetic purposes.

CAPABILITY SUBCLASSES are soil groups within one class; they are designated by adding a small letter, *e*, *w*, *s*, or *c* to the class numeral, for example, IIe. The letter *e* shows that the main limitation is hazard of erosion; *w* shows that water in or on the soil interferes with plant growth or cultivation (in some soils the wetness can be partly corrected by artificial drainage) ; *s* shows that the soil is limited mainly because it is shallow, droughty, salty, alkaline, or stony; and *c*, used in some parts of the United States, shows that the main limitation is climate that is too cold or too dry.

In class I there are no subclasses, because the soils of this class have few limitations. Class V can contain, at most, only the subclasses indicated by *w*, *s*, and *c*, because the soils in class V are subject to little or no erosion, though they have other limitations that restrict their use largely to pasture or range, woodland, wildlife habitat, or recreation.

CAPABILITY UNITS are soil groups within the subclasses. The soils in one capability unit are enough alike to be suited to the same crops and pasture plants, to require similar management, and to have similar productivity and other responses to management. Thus, the capability unit is a convenient grouping for making many statements about management of soils. Capability units are generally designated by adding an Arabic numeral to the subclass symbol, for example, IIIe-6 or IIIs-6. Thus, in one symbol, the Roman numeral designates the capability class, or degree of limitations; the small letter indicates the subclass, or kind of limitation; and the Arabic numeral specifically identifies the capability unit within each subclass. The Arabic numerals are also used to indicate the susceptibility of the soil to soil blowing. The numbers range from 2, which is very high, to 7, which is slight. The letter P indicates the presence of a sodic claypan in the subsoil, and the letter L indicates that the soil is calcareous. Following the subclass designation in capability units in classes V, VI, and VII is an abbreviation of the name of the range site in which the soils of this unit have been classified.

Management by capability units

In the following pages each of the capability units in the survey area is described and use and management of the soils in each unit are suggested. The units are not numbered consecutively, because not all the units in the statewide system are represented in this county. The capability classification of each individual soil is designated at the end of each mapping unit in the section "Descriptions of the Soils."

CAPABILITY UNIT IIe-4L

This unit consists of nearly level, well drained and moderately well drained soils. The surface layer is very fine sandy loam or silty clay loam. The subsoil ranges from loam to silty clay.

These soils generally have good tilth. They have a deep root zone that is readily penetrated by roots, moisture, and air. They are susceptible to wind erosion and in some locations are subject to occasional flooding. Available water capacity is high, and fertility is medium. Permeability is moderate, moderately slow, or slow. The supply of organic matter is low.

About 70 percent of the acreage is cultivated. The soils are suited to all locally grown crops. They are also suited to pasture, hay, trees, and other less intensive uses. Small grain, alfalfa, and corn are the chief crops.

Stripcropping, stubble mulching, and rough tillage are commonly needed in erosion control. The use of crop residue and manure in addition to grasses and legumes in the crop rotation helps maintain the supply of organic matter. Summer fallow, minimum tillage, and weed control conserve moisture.

CAPABILITY UNIT IIe-5

This unit consists of well drained, nearly level to undulating soils. The surface layer is silt loam or loam. The subsoil is silt loam or fine sandy loam.

Available water capacity is moderate or high, and fertility is medium or high. Permeability is moderate or moderately rapid. The organic-matter content is moderate or high. The soils have a deep root zone that is easily penetrated by roots, air, and moisture. Tilth is good. The soils are moderately susceptible to soil blowing and slightly or moderately susceptible to water erosion.

These soils are suited to all crops commonly grown in the survey area and are also suited to pasture, hay, trees, and other less intensive uses. Most of the acreage

is cultivated, but some of it is irrigated and well suited to irrigation. Small grain, corn, and alfalfa are the main crops.

The use of crop residue and planting grasses and legumes in the crop rotation help to maintain the organic-matter content and reduce soil blowing. Stripcropping and stubble mulch tillage are used to control erosion. Single-row tree belts trap snow, provide additional moisture for crop production, and protect the soil from blowing. Summer fallowing stores soil moisture for the succeeding crop, but it increases the hazard of soil blowing. It should be used only for weed control.

CAPABILITY UNIT IIe-6

This unit consists of well drained and moderately well drained soils. The surface layer and subsoil are loam, silt loam, or clay loam.

Available water capacity is high, and fertility is medium to high. Permeability is moderate or moderately slow. The organic-matter content is moderate or high. The soils have a deep root zone that is readily penetrated by roots, air, and moisture. Tilth is good. The soils are slightly susceptible to soil blowing and moderately susceptible to water erosion.

These soils are suited to all crops commonly grown in the survey area. They are also suited to pasture, hay, trees, and other less intensive uses. Most of the acreage is cultivated. Small grain, corn, and alfalfa are the main crops.

The use of crop residue and planting grasses and legumes in the rotation help to maintain the organic-matter content and fertility and assist in controlling erosion. Single-row tree belts trap snow, provide additional moisture for crop production, and protect the soil against soil blowing. Summer fallowing stores moisture, but it increases the hazard of soil blowing; therefore, it should be used only for weed control.

CAPABILITY UNIT IIe-7

Grail silty clay loam, 3 to 6 percent slopes, the only soil in this capability unit, is well drained. This gently sloping soil has a subsoil of silty clay loam or silty clay.

Available water capacity is high, and permeability is moderately slow. Fertility and organic-matter content are high. Tilth is good.

If tilled when moist, this soil forms stable granules and blocks that resist blowing. It has a deep root zone that is readily penetrated by roots, air, and moisture. It is moderately susceptible to water erosion, but only slightly susceptible to blowing.

About 75 percent of the acreage is cultivated. All crops commonly grown in the survey area are well suited. Small grain, corn, and alfalfa are the main crops. The soil is also suited to pasture, hay, trees, and other less intensive uses.

Use of crop residue and planting grasses and legumes in the rotation maintain organic-matter content and fertility and help in controlling erosion. Field windbreaks and stubble mulch tillage conserve moisture and help in erosion control.

CAPABILITY UNIT IIes-4L

Hamerly loam, 1 to 3 percent slopes, is the only soil in this capability unit. It is somewhat poorly drained, nearly level, and undulating. This soil is limy throughout the profile. The subsoil is loam.

Available water capacity and fertility are high. Permeability is moderately slow, and organic-matter content is moderate. Tilth is good. The soil has a deep root zone that is readily penetrated by roots, air, and moisture. Because of its lime content, the soil is very moderately susceptible to soil blowing but only slightly susceptible to water erosion.

About 50 percent of the acreage is cultivated. The soil is well suited to small grain and alfalfa and is also suited to pasture, hay, trees, and other less intensive uses.

The use of crop residue and planting grasses and legumes in the rotation help to maintain the organic-matter content and fertility and assist in controlling soil blowing.

CAPABILITY UNIT IIw-4L

Colvin silty clay loam is the only soil in this capability unit. It is nearly level and poorly drained and is limy throughout the profile. The subsoil is silty clay loam. The soil has a water table within 2 to 4 feet of the surface for most of the growing season.

Available water capacity and organic-matter content are high. Fertility is medium. Permeability is moderate. Tilth and workability are favorable if tillage can be done when soil moisture is not excessive. The soil has a deep root zone that is readily penetrated by roots, but permeability to air and moisture is moderately slow. Because of the lime content, the soil is susceptible to soil blowing. A seasonal high water table is the main management concern. Some areas are slightly saline to moderately saline.

Most of the acreage is in native grass. If drained, this soil is well suited to small grain and flax. Undrained areas are sometimes suited to late planted small grain and flax and to hay and pasture. Drainage ditches help control flooding and the water table. Summer fallow tends to intensify the wetness problem and should be used only for weed control.

CAPABILITY UNIT IIw-6

This capability unit consists of nearly level, poorly drained and very poorly drained soils in shallow closed depressions on uplands. The soils are intermittently ponded by runoff from higher areas. The surface layer is silt loam or silty clay loam. The subsoil is silty clay loam or silty clay.

Available water capacity, organic-matter content, and fertility are high. Permeability is slow. The soils are easily tilled when dry, but they are wet for long periods after runoff. They have a deep root zone that is readily penetrated by roots. Permeability to air and moisture is slow. Ponding by runoff is the main management concern.

About 50 percent of the acreage is cultivated. The soils are typically cultivated with the surrounding cropland. Planting is delayed several weeks because they dry out slowly. Surface drains can remove excess water where there are satisfactory outlets. Even in drained areas, wetness is a limitation. Water is removed slowly because drainage ditches can have only a slight gradient. Undrained areas are sometimes used

for late seeded crops of small grain and flax. The soils are well suited to pasture and hay. Forage yields are high because of abundant moisture.

CAPABILITY UNIT IIs-4

This unit consists of moderately well drained and well drained, nearly level soils. These soils have a silty clay surface layer and subsoil.

Available water capacity is high, and permeability is slow. Fertility is high. The organic-matter content is high in most areas but is low in a few areas.

These soils should be tilled at the proper moisture content. They are hard when dry and sticky and plastic when wet. They have a deep root zone that is readily permeable to roots. They are slower to warm in spring than loamy soils. The surface layer tends to slake, making it moderately or highly susceptible to soil blowing, particularly if the soil is summer fallowed or fall plowed.

Most of the acreage is cultivated. The soils are well suited to crops commonly grown in the area. They are also well suited to hay, pasture, trees, and other less intensive uses.

Use of crop residue and planting grasses and legumes in the rotation help to maintain the organic-matter content and reduce soil blowing. Summer fallowing increases the hazard of soil blowing and should be used for weed control.

CAPABILITY UNIT IIc-6

This unit consists of nearly level, well drained and moderately well drained soils. These soils have a surface layer and subsoil of loam, clay loam, or silt loam.

Available water capacity is high, and permeability is moderate or moderately slow. Fertility is medium or high. The organic-matter content is high or moderate. Tilth is good.

These soils have a deep root zone that is readily penetrated by roots, air, and moisture. The hazard of water erosion and soil blowing is slight. Lack of rainfall and available moisture is the main limitation. Drainage of the common small depressions, where feasible, and removal of stones would facilitate fieldwork.

About 75 percent of the acreage is cultivated. All locally grown crops are suited. Small grain and alfalfa are the main crops. The soils are also suited to pasture, hay, trees, and other less intensive uses.

Use of crop residue and manure and planting grasses and legumes in the rotation help in maintaining the organic-matter content. Moisture can be conserved by summer fallowing, minimum tillage, and weed control. The use of rough tillage, standing stubble, annual buffers, and single-row tree belts to trap snow will provide additional moisture for crop production.

CAPABILITY UNIT IIc-7

This capability unit consists of nearly level, well drained and moderately well drained soils. The surface layer is silty clay loam. The subsoil is silty clay loam or clay.

Available water capacity, organic-matter content, and fertility are high. Permeability is moderately slow. Tilth is good. If tilled when moist, the soils form stable granules and blocks that resist soil blowing. They have a deep root zone that is readily penetrated by roots, moisture, and air. Water erosion and soil blowing are minor concerns. Lack of rainfall and available moisture are the main limitations.

About 80 percent of the acreage is cultivated. The soils are suited to all crops commonly grown in the survey area and to pasture, hay, trees, and other less intensive uses. Small grain and alfalfa are the most common crops.

The use of crop residue and manure and planting grasses and legumes in the crop rotation help to maintain the organic-matter content. Moisture can be conserved by summer fallow, minimum tillage, and weed control. Rough tillage, stubble mulch tillage, annual buffers, and single-row tree belts to trap snow provide additional moisture for crop production.

CAPABILITY UNIT IIIe-3

This capability unit consists of well drained, nearly level and gently sloping soils on uplands. The surface layer and subsoil are fine sandy loam. The substratum ranges from loamy fine sand to clay loam.

Available water capacity is moderate to high. Permeability is moderately rapid in about half the acreage. Some soils, underlain by glacial till, have moderately slow permeability in the substratum. Fertility is dominantly medium to high, but is low in a few areas. Organic-matter content is moderate in most of the soils, but low in a few.

These soils have a deep root zone and are easily penetrated by roots, air, and moisture. They are easily tilled. They are highly susceptible to soil blowing if cultivated and not protected. The gently sloping or undulating soils are moderately susceptible to erosion. The soils warm up rapidly in spring and are among the first to be ready for planting.

More than 50 percent of the acreage is cultivated. The soils are well suited to all crops commonly grown in the survey area and to hay, pasture, trees, and other less intensive uses. Small grain, corn, and alfalfa are the main crops. Flax produces only a small amount of residue and is easily damaged by windblown sand.

The use of manure and crop residue in addition to grasses and legume in the crop rotation help to maintain the organic-matter content. A combination of practices is required to control erosion. Crop residue and stubble mulching combined with stripcropping or patterned windbreak planting are needed to control soil blowing. Tillage should be kept to the minimum needed for weed control and preparation of seedbed. Cover crops, buffer strips, and grass in the cropping system also help to control erosion. Occasionally emergency tillage, which roughens the surface, is required. Summer fallow should be used only to control weeds because of erosion and the limited amount of moisture storage.

CAPABILITY UNIT IIIe-4

Nutley silty clay, 3 to 6 percent slopes, is the only soil in this capability unit. It is gently sloping and well drained. The subsoil is silty clay.

The organic-matter content is moderate, and the available water capacity is high. Fertility is medium, and permeability is slow. The soil is slightly sus-

ceptible to water erosion and moderately susceptible to soil blowing.

This soil should be tilled at the proper moisture content. It is hard when dry and sticky and plastic when wet.

The major management concerns are maintaining the organic-matter content and fertility, improving and maintaining tilth, and controlling erosion.

This soil is well suited to crops commonly grown in the survey areas and to pasture, hay, trees, and other less intensive uses. The largest acreage is in small grain.

Planting grasses and legumes in the rotation and the use of crop residue and stubble mulch help to maintain the organic-matter content and tilth. Stripcropping and field shelterbelts help to control erosion.

CAPABILITY UNIT IIIe-5

This unit consists of well drained, sloping and gently rolling soils. The surface layer is silt loam. The subsoil is silt loam or fine sandy loam.

Available water capacity is moderate to high, and fertility is medium to high. Permeability is moderate to moderately rapid, and the organic-matter content is moderate. Tilth is good. The soils have a deep root zone that is readily permeable to roots, air, and moisture. They are moderately susceptible to soil blowing and highly susceptible to water erosion, especially when in row crops.

About 50 percent of the acreage is cultivated. The soils are suited to most crops commonly grown in the survey area. They are also well suited to pasture, hay, trees, and other less intensive uses. Small grain and alfalfa are the most common crops. Corn is seldom grown because of the risk of erosion when rows are cultivated up and down slope.

The use of crop residue is necessary for controlling erosion. The amount is generally inadequate for protection of fallow land. Stripcropping or use of windbreaks, cover crops, or buffer strips is essential. Summer fallow and stubble mulch tillage are used to store moisture for the succeeding crop. Tillage and stripcropping should be on the contour. Grassed waterways are needed where water concentrates.

CAPABILITY UNIT IIIe-6

This unit consists of well drained and moderately well drained, sloping or gently rolling soils. The surface layer and subsoil are loam or silt loam.

Available water capacity is high, and fertility is medium to high. Permeability is moderate or moderately slow. The organic-matter content is moderate to high. The soils have a deep or moderately deep root zone that is readily penetrated by roots, air, and moisture. Tilth is good. The soils are slightly susceptible to soil blowing but highly susceptible to water erosion on cultivated fields. Soil is washed from ridges and upper slopes during intense rainfall and rapid snowmelt.

About 50 percent of the acreage is cultivated. The soils are suited to most crops commonly grown in the survey area. They are also well suited to pasture, hay, trees, and other less intensive uses. Small grain, flax, and alfalfa are the main crops. Corn is seldom grown because of the risk of erosion when rows are cultivated up and down slope.

Stubble mulch tillage, stripcropping, and the use of crop residue are the main practices used to control erosion. Grassed waterways are needed where water concentrates. Contour stripcropping helps greatly to control erosion, but in many areas individual strips are small because of irregular slopes. Summer fallowing stores moisture, but it increases the hazard of soil blowing and water erosion and should be used only for weed control.

CAPABILITY UNIT IIIe-6P

Only Niobell-Williams loams, 3 to 6 percent slopes, is in this unit. These soils are moderately well drained and gently sloping. The subsoil is firm, dense clay loam.

Available water capacity is high, and fertility is medium. Permeability is slow. The organic-matter content is moderate. The soils have a deep root zone that is slowly penetrated by roots, air, and moisture. They contain salts and alkali in the subsoil and underlying material. They are moderately susceptible to water erosion and slightly susceptible to soil blowing.

About 50 percent of the acreage is cultivated. The soils are best suited to small grain, alfalfa, and tame grasses. They are also well suited to native grasses but are moderately well suited to tree growth.

The use of alfalfa, sweetclover, and tame grasses in the rotation helps to maintain the organic-matter content and to improve soil structure, permeability, and tilth. Stubble mulch tillage, the use of crop residue, and stripcropping are practices that help to conserve moisture and to control erosion. Deep tillage and summer fallow benefit the soils by increasing the intake of water and leaching out the salts.

CAPABILITY UNIT IIIe-7

Regent silty clay loam, 3 to 9 percent slopes, the only soil in this capability unit, is well drained. The subsoil is silty clay.

Available water capacity is high, and fertility is medium. Permeability is slow, and organic-matter content is moderate. Tilth is good. If tilled when moist, the soil forms stable granules and blocks that resist soil blowing. It has a moderately deep root zone that is readily penetrated by roots, air, and moisture. The soil is slightly susceptible to soil blowing and highly susceptible to water erosion.

This soil is well suited to most crops commonly grown in the survey area and to pasture, hay, trees, and other less intensive uses. Small grain and alfalfa are the main crops. Corn is seldom grown because of the risk of erosion when rows are cultivated up and down slope.

Stubble mulch tillage, stripcropping, and the use of crop residue are the main practices used to control erosion. Contour stripcropping also helps. Grassed waterways are needed where water concentrates. Summer fallowing stores moisture but increases the hazard of soil blowing and water erosion; therefore, it is best used for weed control.

CAPABILITY UNIT IIIes-3

This capability unit consists of well drained and

somewhat excessively drained, nearly level and gently sloping soils. The surface layer and subsoil are coarse sandy loam overlying coarse sand and gravel at a depth of 20 to 40 inches.

Available water capacity is low, and fertility is medium. Permeability is moderately rapid throughout the subsoil and very rapid in the underlying sand and gravel. The organic-matter content is moderate.

These soils have a moderately deep root zone. They are easily tilled and readily permeable to roots, air, and moisture. The soils are susceptible to soil blowing if cultivated and left unprotected. The gently sloping soils are moderately susceptible to water erosion. The soils warm up rapidly in spring and are among the first to be ready for planting.

The major management needs are controlling erosion, conserving moisture, and maintaining organic-matter content and fertility.

About 75 percent of the acreage is cultivated. The soils are well suited to the crops commonly grown in the survey area and to hay, pasture, trees, and other less intensive uses. Small grain is the main crop. Flax produces only a small amount of residue and is easily damaged by windblown sand. The soils are somewhat droughty.

Planting grasses and legumes in the crop rotation and the use of manure and crop residue help to maintain the organic-matter content. A combination of practices is required to control erosion. Narrow stripping and the use of crop residue or stubble mulch are essential. Tree windbreaks also help, but the number of suitable species, particularly those having sufficient height at maturity, is limited. Summer fallow should be used only to control weeds because of erosion.

CAPABILITY UNIT IIIes-6

Only Bowdle-Stady loams, 3 to 6 percent slopes, is in this capability unit. These soils are well drained and gently sloping. The subsoil is loam overlying coarse sand and gravel at a depth of 20 to 40 inches.

Available water capacity is moderate, and fertility is medium. Permeability is moderate throughout the subsoil and very rapid in the underlying sand and gravel. The organic-matter content is moderate or high. The soils have a moderately deep root zone. They are easily tilled and readily permeable to roots, air, and moisture. Soil blowing and water erosion are moderate hazards.

The main management concerns are controlling erosion and droughtiness. Maintaining fertility and tilth are also important.

About 80 percent of the acreage is cultivated. The soils are suited to the crops commonly grown in the survey area and to pasture, hay, trees, and other less intensive uses. Small grain, flax, corn, and alfalfa are the main crops.

Planting grasses and legumes in the crop rotation helps to maintain the organic-matter content. The use of crop residue is generally inadequate for protection of fallow land. Stripcropping or use of windbreaks or cover crops is essential. Summer fallow should be used only for weed control because of erosion and the limited amount of moisture storage.

CAPABILITY UNIT IIIes-33

This capability unit consists of well drained and excessively drained, nearly level and gently sloping soils. The surface layer is loamy coarse sand, coarse sandy loam, and loamy sand. The subsoil is coarse sandy loam. Sand and gravel is at a depth of 20 to 40 inches.

Available water capacity is low. Permeability is moderately rapid in the subsoil and very rapid in the underlying sand and gravel. Fertility is medium, and organic-matter content is moderate or high.

These soils have a moderately deep root zone. They are easily tilled and are readily permeable to roots, air, and moisture. They warm up rapidly in spring and are among the first to be ready for planting. They are highly susceptible to soil blowing if cultivated and left unprotected. The gently sloping soils are moderately susceptible to erosion.

The major management need is controlling erosion. Conserving moisture and maintaining fertility and organic-matter content are also important.

About 75 percent of the acreage is cultivated. These soils are suited to most crops commonly grown in the survey area and are well suited to hay, pasture, and other less intensive uses. Small grain and alfalfa are the most common crops. Corn is seldom grown because of the risk of soil blowing before ground cover is established. The soils are droughty.

Planting grasses and legumes in the crop rotation and the use of crop residue and manure help to maintain the organic-matter content. A combination of practices is required to control soil blowing. Narrow stripping and the use of crop residue or stubble mulch are essential. Tree windbreaks also help, but the number of suitable species is limited. Tillage should be kept to the minimum needed for weed control and preparation of seedbed. Cover crops, buffer strips, and grass in the cropping system also help to control erosion. Occasionally emergency tillage, which roughens the surface, is required. Summer fallow should be used only to control weeds because of erosion and the limited amount of moisture storage. A small acreage is used for irrigation and is well suited to irrigated crops.

CAPABILITY UNIT IIw-3

Only Fossum fine sandy loam is in this capability unit. This nearly level, poorly drained sandy soil is in shallow depressions and glacial channels on outwash plains.

The organic-matter content is high, and the available water capacity is low. Permeability is moderately rapid, and fertility is medium. When drained, the soil is severely susceptible to soil blowing. The main management concerns are maintaining organic-matter content and fertility and controlling soil blowing.

Drained areas are well suited to small grain, flax, and tame grasses. Undrained areas are suited to native grasses and water tolerant trees, such as willows and cottonwood.

Planting grasses in the rotation and incorporating crop residue help to maintain the organic-matter content and fertility. Stubble mulching helps to control soil blowing.

CAPABILITY UNIT IIIw-4

This unit consists of nearly level, poorly drained, and very poorly drained clay soils in depressions and in oxbows along streams.

The organic-matter content is high. Available water capacity is moderate. Fertility is medium. Permeability is very slow or slow. The soils are moderately susceptible to soil blowing. The main management concerns are removing excess water and controlling soil blowing.

When drained, these soils are suited to small grain, flax, and tame grasses. Artificial drains help prevent excess ponded water. Undrained areas are mostly in grass and used for pasture, hay, or wildlife habitat.

CAPABILITY UNIT IIIw-4L

Grano silty clay is the only soil in this capability unit. It is nearly level and very poorly drained.

Available water capacity is high, and permeability is slow. Fertility is medium, and organic-matter content is high. The hazard of soil blowing is moderate.

Less than 10 percent of the acreage is cultivated. When drained, this soil is suited to small grain, flax, and tame grasses.

The major management needs are maintaining tilth, minimizing ponding of surface water, and controlling soil blowing. Timely tillage is necessary because there is a narrow moisture range in which the soil will pulverize and form a good seedbed. Artificial drains with adequate outlets prevent excess water ponding. Incorporating crop residue and stubble mulching aid in controlling soil blowing. Undrained areas are mostly in grass and are used for pasture, hay, or wildlife habitat. Grasses and legumes in rotation help maintain tilth and organic-matter content.

CAPABILITY UNIT IIIw-7

Parnell silty clay loam is the only soil in this capability unit. It is a deep, nearly level, and very poorly drained soil that has a silty clay subsoil. It is in depressions and is usually ponded for part of the growing season.

The organic-matter content, available water capacity, and fertility are high. Permeability is slow. The soil is slightly susceptible to soil blowing. The main management concern is excess water that ponds on the surface.

Less than 25 percent of the acreage is cultivated. When drained, this soil is well suited to small grain, flax, and tame grasses. Undrained areas are mostly in grass and used for pasture, hay, or wildlife habitat. In drier years some of the undrained areas are used for late seeded crops of small grain or flax. The main management concern for consistent crop production is artificial drainage. This is feasible only where good outlets can be located.

Planting grasses and legumes in the rotation helps to maintain tilth and the organic-matter content.

CAPABILITY UNIT IIIs-4L

Divide loam, the only soil in this capability unit, is nearly level, somewhat poorly drained, and calcareous. It is moderately deep over sand and gravel. The subsoil is loam and is underlain by coarse sand and gravel at a depth of 20 to 40 inches.

The organic-matter content is high. Available water capacity is low, and fertility is medium. Permeability is moderate throughout the subsoil and very rapid in the underlying sand and gravel. The soil is moderately susceptible to soil blowing. The main management concerns are maintaining organic-matter content and fertility and controlling soil blowing.

This soil is well suited to small grain and tame grasses and to pasture, hay, and other less intensive uses.

Planting grasses and legumes in the rotation and incorporating crop residue help to maintain the organic-matter content. Stripcropping, stubble mulching, and field shelterbelts help to control soil blowing.

CAPABILITY UNIT IIIe-6

Bowdle loam, 1 to 3 percent slopes, is the only soil in this capability unit. It is nearly level and well drained. The subsoil is loam overlying coarse sand and gravel at a depth of 20 to 40 inches.

The organic-matter content is high. Available water capacity is moderate, and fertility is medium. Permeability is moderate throughout the subsoil and very rapid in the underlying sand and gravel. The soil is moderately susceptible to soil blowing. The main management concerns are maintaining organic-matter content and fertility and controlling soil blowing.

This soil is well suited to crops commonly grown in the survey area and to pasture, hay, trees, and other less intensive uses. Small grain, alfalfa, and corn are the main crops.

Planting grasses and legumes in the rotation and incorporating crop residue help to maintain the organic-matter content. Stubble mulching and field shelterbelts help control soil blowing. Summer fallow should be used only for weed control because of erosion and the limited amount of moisture storage.

CAPABILITY UNIT IIIe-6P

Only Niobell-Williams loams, 1 to 3 percent slopes, is in this capability unit. These soils are nearly level and moderately well drained and well drained. The subsoil is firm, dense clay loam.

The organic-matter content is moderate. Available water capacity is high, and fertility is medium. Permeability is slow. The soils are slightly susceptible to soil blowing. They have a deep root zone that is slowly penetrated by roots, air, and moisture. They contain salts and alkali in the subsoil and underlying material. The main management concerns are maintaining organic-matter content and fertility, improving and maintaining tilth, and controlling soil blowing.

These soils are suited to small grain, flax, and alfalfa, and are well suited to pasture and hay. They are poorly suited to corn and tree growth.

Planting grasses and legumes in the rotation and incorporating manure and crop residue help to maintain the organic-matter content and tilth.

CAPABILITY UNIT IVe-2

This unit consists of well drained, nearly level, and undulating soils. The surface layer is loamy fine sand, and the underlying material ranges from loamy sand to clay loam.

Available water capacity is moderate or high. Per-

meability is rapid in most soils. A few soils have moderately slow permeability in the clay loam subsoil and underlying material. The organic-matter content is moderate or high, and fertility is medium. The soils are severely susceptible to soil blowing if cultivated and unprotected. They are slightly susceptible to water erosion. They have a deep root zone that is readily penetrated by roots, air, and moisture.

About 35 percent of the acreage is cultivated. The soils are suited to all crops commonly grown in the survey area. They are also well suited to hay, pasture, trees, and other less intensive uses. Small grain and alfalfa are the main crops. Flax produces only a small amount of residue and is easily damaged by windblown sand.

Planting grasses and legumes in the crop rotation and the use of crop residue and manure help to maintain the organic-matter content. A combination of practices is required to control soil blowing. Narrow stripcropping or tree windbreaks combined with crop residue or stubble mulching are needed. The soils are not fall plowed or summer fallowed because of soil blowing. Tillage should be kept to the minimum needed for weed control and preparation of seedbed. Occasionally emergency tillage, which roughens the surface, is required to control erosion.

CAPABILITY UNIT IVe-3

This unit consists of well drained, rolling or sloping soils. The surface layer is fine sandy loam. In most areas the subsoil is fine sandy loam, but in others it is clay loam.

Available water capacity ranges from moderate to high. Permeability is moderately rapid throughout most soils. In some soils it is moderately rapid in the surface layer and moderately slow in the subsoil. The organic-matter content is moderate or high. Fertility is medium. The soils have a deep root zone that is readily permeable to roots, air, and moisture. Tilth is good. The soils are highly susceptible to soil blowing if cultivated and unprotected and are also highly susceptible to water erosion.

About 35 percent of the acreage is cultivated. The soils are well suited to the crops commonly grown in the survey area and to hay, pasture, trees, and other less intensive uses. Small grain and alfalfa are the most common crops. Flax produces only a small amount of residue and is easily damaged by windblown sand.

Planting grasses and legumes in the crop rotation and using crop residue and manure help to maintain the organic-matter content. A combination of practices is required to control erosion. Crop residue and stubble mulching combined with stripcropping or patterned windbreak planting are also necessary. Grassed waterways are needed where water concentrates. Tillage should be kept to the minimum needed for weed control and preparation of seedbed. Occasionally emergency tillage, which roughness the surface, is required to control erosion. Summer fallow should be used only to control weeds because of erosion and the limited amount of moisture storage.

CAPABILITY UNIT IVe-4L

Only Zahl-Williams loams, 3 to 9 percent slopes, is in this capability unit. It consists of deep, well drained, rolling soils on convex ridges in uplands. The surface layer and subsoil are loam. The soils have a thin surface layer that is calcareous.

Available water capacity is high, and fertility is low. The organic-matter content is moderate. Permeability is moderate in the upper layer and moderately slow below. The soils have a deep root zone that is readily penetrated by roots, air, and moisture. They are moderately susceptible to soil blowing because of the lime content. They are also highly susceptible to water erosion.

About 35 percent of the acreage is cultivated. The soils are easily tilled. They are suited to cultivated crops if erosion is controlled. They are also well suited to pasture, hay, and wildlife habitat. Small grain is the most common crop. The soils are poorly suited to row crops because of water erosion when rows extend up and down slopes. They are also not well suited to trees.

Stubble mulch tillage, stripcropping, and the use of crop residue are the main practices used to control erosion. Contour stripcropping also helps. Grassed waterways are needed where water concentrates. Summer fallowing stores moisture, but increases the hazard of soil blowing and water erosion; therefore, it should be used only for weed control.

CAPABILITY UNIT IVe-5

Only Linton-Mandan silt loams, 9 to 15 percent slopes, is in this capability unit. These soils are on uplands and are well drained. The subsoil is silt loam.

Available water capacity is high, and fertility is medium to high. Permeability and organic-matter content are moderate. Tilth is good. The soils have a deep root zone that is readily penetrated by roots, air, and moisture. They are moderately susceptible to soil blowing and highly susceptible to water erosion.

About 25 percent of the acreage is cultivated. The soils are best suited to small grain, alfalfa, and tame grasses. They are also well suited to pasture, hay, and wildlife habitat and are moderately well suited to trees. The soils are not suited to row crops.

Stubble mulch tillage, the use of crop residue, frequent planting of grasses and legumes in the crop rotation, and winter cover crops in combination with cross-slope stripcropping or tree windbreaks are practices used to control erosion and to conserve moisture. Grassed waterways are needed where water concentrates. Summer fallow stores moisture, but increases the hazard of soil blowing and water erosion; therefore, it should be used only for weed control.

CAPABILITY UNIT IVe-5L

Banks loam is the only soil in this capability unit. It is somewhat excessively drained and nearly level. The underlying material is stratified loamy fine sand and fine sand.

Available water capacity, fertility, and organic-matter content are low. Permeability is moderately rapid. Tilth is good. The soil has a deep root zone that is readily permeable to roots, air, and moisture. It is droughty and susceptible to soil blowing if cultivated and unprotected.

About 50 percent of the acreage is cultivated. The

soil is best suited to alfalfa. It is also well suited to hay, pasture, trees, and other less intensive uses. Small grain is not well suited because of droughtiness.

Planting grasses and legumes in the rotation and incorporating manure and crop residue help to maintain the organic-matter content. Stubble mulching combined with stripcropping or patterned shelterbelts are needed to control soil blowing. Tillage should be kept to the minimum needed for weed control and seedbed preparation.

CAPABILITY UNIT IV$_{e}$-6

Only Max-Zahl loams, 9 to 15 percent slopes, is in this capability unit. These soils are well drained and hilly. The subsoil is loam or clay loam.

Available water capacity is high, and fertility is medium or low. Permeability is moderate in the upper layers and is moderately slow below. The organic-matter content is moderate. The soils have a deep root zone that is readily penetrated by roots, air, and moisture. Tilth is good. The soils are slightly susceptible to soil blowing and highly susceptible to water erosion. Soil is washed from ridges and upper slopes during intense rainfall and rapid snowmelt.

About 25 percent of the acreage is cultivated. The soils are best suited to small grain, alfalfa, and tame grasses. They are also well suited to pasture, hay, and wildlife habitat and are moderately well suited to trees. They are not suited to row crops because of severe water erosion.

Stubble mulch tillage, stripcropping, and the use of crop residue are the main practices used to control erosion. Grassed waterways are needed where water concentrates. Contour stripcropping helps to control erosion, but in many areas individual strips are small because of irregular slope. Summer fallow stores moisture, but increases the hazard of soil blowing and water erosion. It should be used only for weed control.

CAPABILITY UNIT IV$_{es}$-3

This unit consists of well drained to excessively drained, rolling and sloping soils. The surface layer is loamy sand, loamy coarse sand, or coarse sandy loam. The subsoil is coarse sandy loam that is underlain by coarse sand and gravel.

Available water capacity is low or very low. Fertility is medium or low. The organic-matter content is moderate to high. Permeability is moderately rapid in the subsoil and very rapid in the sand and gravel. The soils have a moderately deep root zone. They are easily tilled and readily permeable to roots, air, and moisture. These soils are highly susceptible to soil blowing if cultivated and left unprotected. They also are highly susceptible to water erosion. The main management concerns are controlling erosion, conserving moisture, and maintaining organic matter and fertility.

Less than 50 percent of the acreage is cultivated. The soils are suited to small grain and alfalfa. They are also well suited to hay, pasture, trees, and other less intensive uses. Row crops are not suited because of severe water erosion.

Planting grasses and legumes in the crop rotation and the use of crop residue and manure help to maintain the organic-matter content. A combination of practices is required to control erosion. Narrow stripping and the use of crop residue or stubble mulch are essential. Tree windbreaks also help control erosion, but the number of suitable species is limited. Summer fallow should be used only to control weeds because of erosion. Occasionally emergency tillage, which roughens the surface, is required to control erosion.

CAPABILITY UNIT IV$_{es}$-6

Only Bowdle-Stady loams, 6 to 9 percent slopes, is in this capability unit. These are well drained, sloping soils. The subsoil is loam that is underlain by sand and gravel at a depth of 20 to 40 inches.

Available water capacity is moderate, and fertility is medium. The organic-matter content is moderate or high. Permeability is moderate throughout the subsoil and very rapid in the underlying sand and gravel. Tilth is good.

These soils are easy to work. They have a moderately deep root zone that is readily penetrated by roots, air, and moisture. The soils are slightly susceptible to soil blowing and highly susceptible to water erosion. The main management concerns are droughtiness and controlling erosion.

About 50 percent of the acreage is cultivated. The soils are suited to small grain and alfalfa and to pasture, hay, trees, and wildlife habitat. They are not suited to row crops because of the severe water erosion hazard.

Planting grasses and legumes in the rotation and incorporating crop residue help to maintain the organic-matter content and control erosion. Since the amount of crop residue is generally inadequate for the protection of fallow land, the use of cover crops is essential. Summer fallow should be used only for weed control because of soil blowing and the limited amount of moisture storage.

CAPABILITY UNIT IV$_{w}$-4L

Marysland loam, the only soil in this capability unit, is poorly drained and nearly level. The subsoil is loam that is underlain by coarse sand and gravel at a depth of 20 to 40 inches. This soil has a water table within 1 to 4 feet of the surface during most of the growing season.

Available water capacity is moderate, and fertility is medium. The content of organic matter is high. Permeability is moderate throughout the subsoil and very rapid in the underlying sand and gravel. The soil is generally too wet to cultivate because of its high water table. The high lime content and wetness cause the soil to warm slowly in spring. Roots penetrate easily, but air movement is restricted by excessive moisture content. Excess water erosion and soil blowing are the main concerns of management.

During occasional dry periods this soil can be seeded to flax or late sown small grain. The soil is well suited to pasture, hay, range, and wildlife habitat, but is unsuited to trees.

CAPABILITY UNIT IV$_{s}$-6P

Only Noonan-Miranda complex, 1 to 6 percent slopes, is in this capability unit. This unit is moderately well drained, nearly level, and undulating. The surface layer is loam, silt loam, or very fine sandy loam. The subsoil is dense claypan.

Available water capacity is low to moderate. Fertility is low to medium. Permeability is slow and very slow. The organic-matter content is moderate. The subsoil has a high content of sodium and soluble salts. Penetration by roots is restricted, and movement of air and moisture is slow. The soils are difficult to till, and tilth is generally poor. They are slightly susceptible to soil blowing and moderately susceptible to water erosion.

These soils are seldom cultivated. When cropped, they are best suited to alfalfa and tame grasses. They are also well suited to pasture, hay, and wildlife habitat, but are unsuited to trees. Liberal applications of manure and use of crop residue are needed to improve tilth.

CAPABILITY UNIT Vw-WL

Parnell silty clay loam, very wet, is the only mapping unit in this capability unit. These are deep, very poorly drained, nearly level soils in deep depressions. During most of the growing season the surface is ponded. The surface layer is silty clay loam. The subsoil is silty clay.

Available water capacity, fertility, and organic-matter content are high. Permeability is slow. In most places artificial drainage is impractical.

These soils are too wet to be cultivated but are well suited to native or tame pasture and wildlife habitat. They support dense stands of wetland or moisture loving plants. There is no hazard of erosion. During prolonged dry cycles the soils dry sufficiently to permit an occasional hay harvest. Grazing should be regulated so that only about half the annual growth of desirable plants is consumed.

CAPABILITY UNIT VIe-2

Banks loamy fine sand, the only soil in this capability unit, is somewhat excessively drained and nearly level. The subsoil is fine sand.

Available water capacity, fertility, and organic-matter content are low. Permeability is moderately rapid.

This soil is not suited to cultivated crops because of droughtiness and high susceptibility to soil blowing. It is well suited to native range or hayland and is also suited to trees and wildlife habitat. Careful management of grazing is needed because the range deteriorates rapidly after even a short period of overuse.

CAPABILITY UNIT VIe-CP

Only Noonan-Miranda complex, 6 to 15 percent slopes, is in this capability unit. It consists of deep, moderately well drained, rolling and hilly soils with a dense claypan subsoil. The surface layer is loam, silt loam, or very fine sandy loam. The subsoil is clay loam. The dense claypan is within 5 to 10 inches of the surface in most areas.

Available water capacity is low or moderate. Fertility is low or medium. The content of organic matter is moderate. Permeability is slow or very slow.

These soils are unsuited to cultivated crops because of erosion and poor tilth from the dense claypan. They are also unsuited to trees. The soils are suited to production of native grasses for pasture or hay. Areas that have been cultivated should be reseeded to native or adapted tame grasses. Because range recovers slowly from overuse, good management is necessary for preservation of vegetative cover.

CAPABILITY UNIT VIe-Ov

Straw soils, channeled, is the only mapping unit in this capability unit. These soils are on strongly channeled bottom land of upland streams. The surface layer is loam, fine sandy loam, or clay loam.

Available water capacity, organic-matter content, and fertility are high. Permeability is moderate.

These soils are unsuited to cultivated crops because of dissection by uncrossable stream channels. They are well suited to native range and hay and are also suited to trees and wildlife habitat. Good use of range aids in maintaining productivity.

CAPABILITY UNIT VIe-Sa

This unit consists of well drained and excessively drained, nearly level to hilly soils. In most areas the surface layer is loamy fine sand or loam and the subsoil is loamy sand or fine sand. In a few areas the surface layer is loamy fine sand and the subsoil is clay loam.

Available water capacity ranges from low to high, and fertility is low or medium. The organic-matter content is moderate. Permeability is moderately slow in the soils with a clay loam subsoil and rapid in the rest.

These soils are not suited to cultivated crops because of droughtiness, the high hazard of wind and water erosion, and the slope. They are well suited to native range or hay. They are poorly suited to trees. Only a few areas are favorable for wildlife.

Careful management of grazing is needed because the range deteriorates rapidly after even a short period of overuse. Grass should be seeded in blownout areas. Manure or a straw mulch protects the soil so that the newly seeded grasses can get established.

CAPABILITY UNIT VIe-Si

Linton-Mandan silty loams, 15 to 40 percent slopes, is the only mapping unit in this capability unit. The subsoil is silt loam.

Available water capacity is high, and fertility is medium to high. Permeability and the organic-matter content are moderate. The soils are highly susceptible to water erosion.

These soils are not suited to cultivated crops because of steep slopes. They are well suited to native range and hay. They are poorly suited to trees, although some areas are favorable for wildlife habitat. Areas that are now cultivated should be seeded to grass. A good protective cover is needed on these soils to control runoff and erosion and to maintain productivity. Good use of pasture or range is needed for maintenance and improvement of range. Rangeland benefits from deferred grazing. Brush control is needed in a few places.

CAPABILITY UNIT VIe-Sw

This unit consists of well drained and somewhat excessively drained sloping to steep soils. The surface layer is fine sandy loam, sandy loam, or loam. The subsoil ranges from loamy fine sand to loam.

Available water capacity is very low to low. Fertility is low to medium. The content of organic matter is low. Permeability is moderate or moderately rapid.

Because of steep slopes, droughtiness, and high susceptibility to soil blowing and water erosion, these soils are unsuited to cultivated crops. They are well suited to native range or hay. The soils are poorly suited to trees, but some areas are favorable for wildlife habitat. Careful management is needed because the range deteriorates rapidly from overuse. A good protective cover helps to control runoff and erosion and maintain productivity.

CAPABILITY UNIT VIe-Sy

Parshall fine sandy loam, 9 to 15 percent slopes, is the only soil in this capability unit. The subsoil is fine sandy loam.

Available water capacity is moderate in most areas and very low in a few areas. Fertility is low or medium. The organic-matter content ranges from low to high. Permeability is moderately rapid.

This soil is not suited to cultivated crops because of steep slopes, high susceptibility to soil blowing, and droughtiness. It is well suited to native range or hay. This soil is poorly suited to trees, although some areas are favorable for wildlife habitat.

Careful management of grazing is needed because the range deteriorates rapidly after overuse. A good protective cover is needed to control runoff and erosion and to maintain productivity.

CAPABILITY UNIT VIe-TU

This capability unit consists of well drained, hilly, and steep soils. In some areas there are numerous depressions containing deep, very poorly drained soils. The surface layer is thin loam. In most soils the subsoil is loam or clay loam. In very poorly drained soils the surface layer is silty clay loam and the subsoil is silty clay.

Available water capacity is high in most soils. Fertility is medium to low in most soils and high in very poorly drained soils. The content of organic matter is moderate in most soils and high in very poorly drained soils. Permeability ranges from moderately rapid to slow. The soils are highly susceptible to water erosion.

These soils are unsuited to cultivated crops because of steep slopes. They are well suited to native range and hay. The soils are poorly suited to trees, but some areas are favorable for wildlife habitat. Areas that are now cultivated should be seeded to grass. A good protective cover helps to control erosion and runoff and maintain productivity. Rangeland benefits from deferred grazing. Brush control is needed in a few places.

CAPABILITY UNIT VIw-SL

This unit consists of poorly drained, nearly level to sloping, saline soils. Some soils are on poorly drained bottom land, and others are on lake beaches. The surface layer is loam, sandy loam, clay loam, loamy sand, silt loam, or very fine sandy loam. The soils have a seasonal water table that rises as high as the lower part of the subsoil. Some areas are ponded for several weeks.

Because of poor drainage and a high content of sodium and soluble salts, these soils are unsuited to cultivated crops and trees. They are suited to native grasses for range or hay. Areas that are too wet for grazing or hay are suitable for wildlife habitat.

CAPABILITY UNIT VIs-CD

Heil silty clay loam is the only soil in this capability unit. It is a nearly level, poorly drained claypan soil in large basins and depressions. It is alkaline and in places is moderately saline. Ponding is common for a few days to several weeks in spring.

Although this soil is deep, the dense claypan effectively limits the penetration of roots, air, and moisture. Permeability is very slow. Available water capacity and organic-matter content are moderate.

This soil is not suited to cultivated crops because of a thin surface layer, a dense claypan, and poor drainage. It is also unsuited to trees. The soil is better suited to native pasture and hay. Grazing should be restricted when the soil is wet to prevent trampling and puddling. The wettest areas are suitable for wildlife habitat.

CAPABILITY UNIT VIs-TCP

Only Rhoades complex, 1 to 9 percent slopes, is in this capability unit. It consists of nearly level to sloping claypan soils. The surface layer is loam. The subsoil is dense clay within 5 inches of the surface over most of the area.

Available water capacity and fertility are low. The content of organic matter is moderate. Permeability is very slow. Although the soil is deep, the strongly alkaline dense claypan limits penetration by roots, air, and moisture. In many places that have microrelief, the claypan is exposed at the surface in the lower spots.

These soils are not suited to cultivated crops because of the extremely poor tilth from the dense claypan. They are suited to production of native grasses for pasture or hay. Proper grazing is necessary to maintain a good vegetative cover. The soils are unsuited to trees.

CAPABILITY UNIT VIs-VS

Only soils of the Wabek series are in this capability unit. They are excessively drained and nearly level to steep. The surface layer is loam to gravelly sandy loam that is underlain by coarse sand and gravel.

Available water capacity is very low. Fertility is low. The content of organic matter is moderate. Permeability is moderately rapid.

These soils are unsuited to cultivated crops because of droughtiness and susceptibility to water erosion. They are suited to production of native grasses for hay or range and are also suited to wildlife habitat. The soils are unsuited to trees.

CAPABILITY UNIT VIIe-Sw

Only Cabba-Shale outcrop complex is in this capability unit. It consists of well drained soils with shale or sandstone outcrops on steep uplands. These soils are barren on 10 to 30 percent of the area and occur as ledges, slips, outcrops, and eroded spots.

Available water capacity, fertility, and content of organic matter are low. The soils are readily pene-

trated by roots, air, and moisture. Runoff is very rapid.

These soils are unsuited to cultivated crops because of steep and broken slopes, shallow depth, and severe erosion hazard. They are also unsuited to trees. They are suited to native range. Careful management of grazing is necessary.

CAPABILITY UNIT VIIe-TSa

Seroco fine sand, 9 to 25 percent slopes, is the only soil in this capability unit. It is excessively drained and is hammocky and hilly. The subsoil is fine sand.

Available water capacity is very low. Fertility and content of organic matter are low. Permeability is rapid.

This soil is unsuited to cultivated crops or trees. It is suited to production of native grasses for range or hay. Careful management in grazing is necessary. Soil blowing is a hazard in overgrazed areas. Blowout spots are difficult to vegetate.

CAPABILITY UNIT VIIe-TU

Only Zahl-Cabba complex, 15 to 35 percent slopes, is in this capability unit. It consists of well drained steep soils. The surface layer is very fine sandy loam to silty clay loam. The subsoil is loam or clay loam.

Available water capacity ranges from low to high. Fertility is low. The organic-matter content is low to moderate. Permeability is moderate or moderately slow.

Because of the irregular, steep slope and severe water erosion hazard, these soils are not suitable for cultivated crops or trees. Native grasses for range are suited. Careful management in grazing is necessary.

CAPABILITY UNIT VIIs-1

Only Orthents, loamy, is in this capability unit. It consists of sparsely vegetated waste piles from strip mining.

This land is unsuited to crops and poorly suited to range. It is suited to wildlife habitat. Mine dumps consisting of material that is low in sodium are suited to trees, which must be hand planted.

CAPABILITY UNIT VIIs-Si

This unit consists of nearly level to moderately sloping soils. It has a surface cover of glacial stones and boulders or mine sinks that make up 30 percent of the surface. The surface layer is loam and the subsoil is clay loam.

Available water capacity and fertility are high. The content of organic matter is moderate. Permeability is moderate to moderately slow.

These soils are unsuited to cultivated crops because of the high concentration of stones and boulders. The large number of stones makes hay impractical. These soils are well suited to native range and are also suited to wildlife habitat.

CAPABILITY UNIT VIIIe-1

Only Riverwash, the nearly barren sand bars and mud bars adjacent to the channel of the Missouri River, is in this unit. It is not suitable for crops or range. It is suitable for wildlife.

CAPABILITY UNIT VIIIw-1

This unit consists of depressions, classified as Aquolls, that contain standing water most of the time. They have little agricultural value but provide excellent habitat for waterfowl. The vegetation is cattails, rushes, and reeds.

Yields per acre

The average yields per acre that can be expected of are shown in table 2. In any given year, yields may be higher or lower than those indicated in table 2 because of seasonal variations in rainfall and other climatic factors. Absence of a yield estimate indicates that the crop is not suited to or not commonly grown on the soil or that irrigation of a given crop is not commonly practiced on the soil.

The predicted yields are based mainly on the experience and records of farmers, conservationists, and extension agents. Results of field trials and demonstrations and available yield data from nearby counties were also considered.

The latest soil and crop management practices used the principal crops under a high level of management by many farmers in the county are assumed in predicting the yields. Hay and pasture yields are predicted for varieties of grasses and legumes suited to the soil. A few farmers may be using more advanced practices and are obtaining average yields higher than those shown in table 2.

The management needed to achieve the indicated yields of the various crops depends on the kind of soil and the crop. Such management provides drainage, erosion control, and protection from flooding; the proper planting and seeding rates; suitable high-yielding crop varieties; appropriate tillage, including timely tillage and seedbed preparation and tilling when soil moisture is favorable; control of weeds, plant diseases, and harmful insects; favorable soil reaction and optimum levels of nitrogen, phosphorus, potassium, and trace elements for each crop; effective use of crop residues, barnyard manure, and green-manure crops; harvest with the smallest possible loss; and timely fieldwork.

The predicted yields reflect the productive capacity of the soils for each of the principal crops. Yields are likely to increase as new production technology is developed. The productivity of a given soil compared with that of other soils, however, is not likely to change.

Crops other than those shown in table 2 are grown in the survey area, but because their acreage is small, predicted yields for these crops are not included. The local offices of the Soil Conservation Service and the Cooperative Extension Service can provide information about the productivity and management concerns of the soils for these crops.

Woodland and Windbreaks[3]

McLean County has approximately 25,000 acres of native woodland. The wooded soils are Banks, Havrelon, Lohler, and Trembles. They are on levees, bottom land, flood plains, and low terraces adjacent to the Missouri River and its major tributaries.

The chief trees and shrubs on these soils are Ameri-

[3] DAVID L. HINTZ, forester, Soil Conservation Service.

TABLE 2.—*Yields per acre of crops and pasture*

[All yields were estimated for a high level of management in 1974. Absence of a yield figure indicates the crop is seldom grown or is not suited]

Soil and map symbol	Wheat, spring	Oats	Barley	Flax	Grass-legume hay
	Bu	*Bu*	*Bu*	*Bu*	*Tons*
Aquents:					
Ac					
Aquolls:					
Af					
Arnegard:					
ArA	34	68	58	17	2.5
ArB	31	62	53	15	2.3
ArC	26	52	44	13	1.9
Banks:					
Ba					
Bk	13	30	22	7	1.0
Bowbells:					
BoA	33	68	58	17	2.5
[1] BsB	32	64	54	16	2.4
Bowdle:					
BwA	20	40	34	10	1.5
[1] ByB	19	38	32	9	1.4
[1] ByC	15	32	26	8	1.1
Cabba:					
[1] CaE					
[1] CbF					
Cohagen:					
[1] ChD					
[1] ChE					
Colvin:					
[2] Co	23	46	39	12	1.8
Dimmick:					
[2] Dm	23	46	39	12	1.8
Divide:					
Dv	21	42	36	11	1.6
Falkirk:					
FaA	32	64	54	16	2.4
FaB	26	52	44	13	1.9
[1] FbA	30	59	50	15	2.2
[1] FbB	26	52	44	13	2.0
[1] FbC	20	40	34	11	1.6
Farnuf:					
FfA	28	58	50	14	2.1
FfB	26	54	46	13	2.0
Flasher:					
FlD					0.7
FlE					
Flaxton:					
FnA	24	48	42	12	1.8
FnB	22	45	39	11	1.7
FnC	18	37	31	8	1.4
Fossum:					
[2] Fs	27	54	46	13	2.0
Grail:					
GaA	34	68	58	17	2.5
GaB	31	62	53	15	2.4

TABLE 2.—*Yields per acre of crops and pasture*—Continued

Soil and map symbol	Wheat, spring	Oats	Barley	Flax	Grass-legume hay
	Bu	*Bu*	*Bu*	*Bu*	*Tons*
Grano:					
[2] Gn	20	40	34	10	1.5
Grassna:					
GoA	34	68	58	17	2.5
Hamerly:					
HaA	27	54	46	13	2.0
Harriet:					
[1] Hk					
Havrelon:					
Hn, Ho	29	58	49	14	2.1
Heil:					
Hs					
Krem:					
KrB	19	38	21	6	1.4
Lallie:					
[2] La	23	46	39	12	1.8
Lihen:					
LeB, LeC	13	25	25	7	1.0
[1] LgE					
Linton:					
[1] LmB	24	49	41	12	1.9
[1] LmC	19	38	32	9	1.4
[1] LmD	13	36	22	7	1.1
[1] LmE					
Lohler:					
Lw	30	60	51	15	2.2
Ly	29	58	49	14	2.1
Makoti:					
Ma	29	58	49	14	2.1
Mandan:					
MdA	29	58	49	14	2.1
MdB	26	52	44	13	1.9
MdC	19	38	32	9	1.4
Marysland:					
Mf					
Max:					
MgB	26	52	44	13	1.9
[1] MhC	19	38	32	9	1.4
[1] MlC	18	36	31	8	1.2
[1] MlD	13	30	22	7	1.0
Morton:					
MoC	20	40	34	10	1.5
Niobell:					
[1] NbA	27	54	46	13	2.0
[1] NbB	26	52	44	13	1.9
Noonan:					
[1] NmB	10	26	17	5	0.8
[1] NmD					
Nutley:					
NtA	29	58	49	14	2.1
NtB	26	53	45	13	1.9

TABLE 2.—*Yields per acre of crops and pasture*—Continued

Soil and map symbol	Wheat, spring	Oats	Barley	Flax	Grass-legume hay
	Bu	*Bu*	*Bu*	*Bu*	*Tons*
Orthents:					
Or	--	--	--	--	--
Parnell:					
[2] Pa	26	52	44	13	1.9
[2] Pe	21	42	36	11	1.9
Parshall:					
PhA	23	46	39	12	1.8
PhB	21	42	36	11	1.6
PhC	18	36	31	8	1.2
PhD	--	--	--	--	0.8
PoA	24	48	41	13	1.9
PoB	23	46	39	12	1.8
Regent:					
RgC	27	53	45	13	1.9
Rhoades:					
[1] RhB	--	--	--	--	--
Riverwash:					
Rm	--	--	--	--	--
Roseglen:					
Ro	32	64	54	16	2.4
[1] RpB	29	58	49	14	2.1
[1] RpC	23	46	39	12	1.8
Ruso:					
RsA	15	30	26	8	1.1
[1] RtB	13	26	22	7	1.0
[1] RtC	10	20	17	6	0.8
[1] RxB	12	24	20	6	0.9
[1] RyC	8	17	15	5	0.6
RzA	14	28	24	7	1.1
Seroco:					
SeD	--	--	--	--	--
Sinai:					
Sn	31	62	53	15	2.2
Straw:					
St	32	64	54	16	2.4
Sx	--	--	--	--	2.4
Telfer:					
[1] TlC	--	--	--	--	0.8
Tonka:					
[1] Tp	23	46	39	11	1.6
Trembles:					
Tr	22	36	32	10	1.4
Vebar:					
[1] VwC	18	36	31	8	1.2
Wabek:					
[1] WaB	--	--	--	--	--
[1] WaD	--	--	--	--	--
[1] WbB	--	--	--	--	--
[1] WbD	--	--	--	--	--
Williams:					
WlB	--	--	--	--	--
WmA	29	58	49	14	2.1
WmB	27	54	46	13	2.0
[1] WoA	31	62	53	15	2.2
[1] WoB	27	54	46	13	2.0

TABLE 2.—*Yields per acre of crops and pasture*—Continued

Soil and map symbol	Wheat, spring	Oats	Barley	Flax	Grass-legume hay
	Bu	*Bu*	*Bu*	*Bu*	*Tons*
[1] WoC	21	42	36	11	1.6
[1] WpB	23	46	39	12	1.8
WrB					
Wilton:					
WsA	29	58	49	14	2.1
[1] WtB	27	54	46	13	2.0
[1] WwC	20	40	34	10	1.5
Zahl:					
[1] ZcE					
[1] ZmE					
[1] ZpE					
[1] ZwC	13	30	22	7	1.0

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

[2] Yields estimated for drained soil. Soil is seldom cropped unless drained.

can elm, boxelder, common chokecherry, green ash, plains cottonwood, and several species of willow. Cottonwood and willow are also common on Lallie soils on level bottoms of lake basins and oxbows of old river channels. There are patches of one to 50 acres of woody vegetation throughout the county on the concave north-facing slopes of Arnegard, Bowbells, Cabba, Williams, and Zahl soils. The chief trees and shrubs are bur oak, boxelder, common chokecherry, quaking aspen, saskatoon, serviceberry, silverberry, and silver buffaloberry.

The early settlers used the trees for building materials, fenceposts, and fuel. Currently, the native trees and shrubs are valued primarily for livestock protection, wildlife habitat, recreation, esthetic purposes, and watershed protection.

Windbreaks are established to protect livestock, buildings, and yards from winds and snow. They also help protect fruit trees and gardens and furnish habitat for wildlife. Several rows of both broadleaf and coniferous species provide the most protection.

Field windbreaks are narrow plantings made at right angles to the prevailing wind and at specific intervals across the field, the interval depending on erodibility of the soil (fig. 14). They protect cropland and crops from wind and hold snow on the fields. They also provide food and cover for wildlife.

Environmental plantings help to beautify and screen homes and other buildings and to abate noise around them. The plants, mostly evergreen shrubs and trees, are closely spaced. Healthy planting stock of suitable species planted properly on a well prepared site and maintained in good condition can insure a high degree of plant survival.

Table 3 shows the height that locally adapted trees and shrubs are expected to reach on various kinds of soils in 20 years. The estimates in table 3, based on measurements and observation of established plantings that have been given adequate care, can be used as a guide in planning windbreaks and screens. Additional information about planning windbreaks and screens and the planting and care of trees can be obtained from the local office of the Soil Conservation Service, Extension Service, or local nurserymen.

Range[4]

About 25 percent of the total land area of McLean County is range. Large areas of range occur in the eastern and northeastern parts of the county, on the dead ice moraine in Mercer, Butte, and Rusco communities. Large areas also occur in the extreme western part of the county along Lake Sakakawea. Other areas are along the Painted Woods Creek, Turtle Creek, and Douglas Creek and on the steeper dissected lands along the Missouri River. These major areas of rangeland are on soil associations 2, 3, 4, and 5 (see general soil map).

The acreage in range is generally not well suited to cultivated crops because it is steep or stony and bouldery. Some of the acreage now in grass was plowed and farmed in the 1930's, but was later abandoned because it was not suited to cultivated crops. This acreage was eventually reseeded or allowed to revert to grass. Some of these reverted acreages can be distinguished by their unique vegetative composition.

Most of the range in the county is grazed. A small part is mowed for hay. Small isolated tracts of range surrounded by land used for other purposes furnish habitat for wildlife. About one-tenth of the rangeland is prime wetland habitat for surface feeding ducks, shorebirds, and many other wildlife species.

The native grasslands of the county are important to the livestock industry. They not only provide forage

[4] By H. D. GALT, State range conservationist, Soil Conservation Service.

Figure 14.—**Single row field windbreak on Williams-Bowbells loam.**

for beef cattle, but also for smaller numbers of dairy cattle and sheep. Beef cattle production for feeder markets is the most significant livestock enterprise. According to the 1969 U.S. Census of Agriculture, the return from the sale of beef was about one-third of the market value of all agricultural products sold.

Range sites and range condition

Range sites are distinctive kinds of rangelands differing from each other in their potential productivity, composition and proportion of plant species, and management needs. The major factors that interact to produce a range site are soil, climate, and topography. Soil is commonly the distinguishing factor. Climate throughout a survey area is fairly uniform. Soil properties of greatest influence on range plants and productivity are those affecting water relationships. Soil reaction and salt content also are important.

Over the centuries, a mixture of plants best suited to each range site has developed. This group of plants is called the potential, or climax, plant community for the site. The climax plant community varies slightly from year to year, but the kinds and amounts of plants remain about the same if the site is undisturbed.

The original mixture of plants was so well suited to the soil and climate of the range site that other kinds of plants could not move in unless an area was disturbed. So consistent is the relationship among plants, climate, and soils that the climax plant community can be accurately predicted on an identified soil, even on considerably disturbed sites.

Repeated overuse by grazing animals and excessive burning or plowing result in changes in the kinds, proportions, or amounts of climax plants in the plant community. Depending on the nature and degree of disturbance, some plants increase while others decrease. If disturbance is severe, plants that are not part of the climax plant community can invade. Plant response to grazing depends on the kind of grazing animals, the season of use, and how closely the plant is grazed. If good management follows disturbances, the climax plant community is gradually reestablished unless the soil is seriously eroded.

Range condition, as commonly accepted, is an expression of how the present plant community on a site compares with the climax plant community for that site. The more nearly the present kinds and amounts of plants are like the climax plant mixture, the higher the range condition. The condition is *excellent* if 76 to 100 percent of the present composition is climax for the site. The condition is *good* if the percentage is 51 to 75, *fair* if 26 to 50, and *poor* if 25 or less.

Range condition provides an index to changes that

TABLE 3.—*Windbreaks and environmental plantings*

[The symbol < means less than; the symbol > means greater than. Absence of an entry indicates that trees generally do not grow to the given height on that soil]

Soil and map symbol	Trees having predicted 20-year average heights, in feet, of—				
	<8	8–15	16–25	26–35	>35
Aquents: Ac.					
Aquolls: Af.					
Arnegard: ArA, ArB, ArC		Eastern redcedar, Rocky Mt. juniper, Siberian peashrub, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce.	Siberian elm	Eastern cottonwood.
Banks: Ba, Bk		Ponderosa pine, eastern redcedar, Rocky Mt. juniper.			
Bowbells: BoA		Eastern redcedar, American plum, common chokecherry, Siberian peashrub.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm	Eastern cottonwood.
[1] BsB: Bowbells part		Eastern redcedar, American plum, common chokecherry, Siberian peashrub.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm	Eastern cottonwood.
Williams part		Eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine.	Siberian elm	
Bowdle: BwA	Siberian peashrub, Tatarian honeysuckle, silver buffaloberry, Peking cotoneaster, lilac.	Ponderosa pine, green ash, Siberian crabapple, hackberry, Russian-olive, eastern redcedar.	Siberian elm		
[1] ByB: Bowdle part	Siberian peashrub, Tatarian honeysuckle, silver buffaloberry, Peking cotoneaster, lilac.	Ponderosa pine, green ash, Siberian crabapple, hackberry, Russian-olive, eastern redcedar.	Siberian elm		

TABLE 3.—*Windbreaks and environmental plantings*—Continued

Soil and map symbol	Trees having predicted 20-year average heights, in feet, of—				
	<8	8–15	16–25	26–35	>35
Stady part	Siberian peashrub, Tatarian honeysuckle, silver buffaloberry, Peking cotoneaster, lilac.	Ponderosa pine, green ash, Siberian crabapple, hackberry, Russian-olive, eastern redcedar.	Siberian elm		
[1] ByC: Bowdle part	Siberian peashrub, Tatarian honeysuckle, silver buffaloberry, Peking cotoneaster, lilac.	Ponderosa pine, green ash, Siberian crabapple, hackberry, Russian-olive, eastern redcedar.	Siberian elm		
Stady part	Siberian peashrub, Tatarian honeysuckle, silver buffaloberry, Peking cotoneaster, lilac.	Ponderosa pine, green ash, Siberian crabapple, hackberry, Russian-olive, eastern redcedar.	Siberian elm		
Cabba: [1] CaE. [1] CbF: Cabba part. Shale outcrop part.					
Cohagen: [1] ChD: Cohagen part.					
Vebar part		Ponderosa pine, eastern redcedar, Rocky Mt. juniper.			
[1] ChE: Cohagen part. Vebar part.					
Colvin: Co.					
Dimmick: Dm.					
Divide: Dv	Siberian peashrub.	Ponderosa pine, Black Hills spruce, blue spruce, Russian-olive, eastern redcedar, American plum, common chokecherry.	American elm, green ash.	Siberian elm	Eastern cottonwood.
Falkirk: FaA, FaB		Russian-olive, Siberian peashrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	

TABLE 3.—*Windbreaks and environmental plantings*—Continued

Soil and map symbol	Trees having predicted 20-year average heights, in feet, of—				
	<8	8–15	16–25	26–35	>35
[1] FbA:					
Falkirk part	---	Russian-olive, Siberian pea-shrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	---
Max part	---	Russian-olive, Siberian pea-shrub, common chokecherry, eastern redcedar, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	Siberian elm, American elm, green ash, ponderosa pine.	---	---
[1] FbB:					
Falkirk part	---	Russian-olive, Siberian pea-shrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	---
Max part	---	Russian-olive, Siberian pea-shrub, common chokecherry, eastern redcedar, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	Siberian elm, American elm, green ash, ponderosa pine.	---	---
[1] FbC:					
Falkirk part	---	Russian-olive, Siberian pea-shrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	---
Max part	---	Russian-olive, Siberian pea-shrub, common chokecherry, eastern redcedar, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	Siberian elm, American elm, green ash, ponderosa pine.	---	---

TABLE 3.—*Windbreaks and environmental plantings*—Continued

Soil and map symbol	Trees having predicted 20-year average heights, in feet, of—				
	<8	8-15	16-25	26-35	>35
Farnuf: FfA, FfB	---	Russian-olive, Siberian peashrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	---
Flasher: FlD, FlE.					
Flaxton: FnA, FnB, FnC	---	Siberian peashrub, eastern redcedar, Rocky Mt. juniper, common chokecherry, Tatarian honeysuckle, American plum.	Siberian elm, ponderosa pine, American elm, green ash, Russian-olive.	---	---
Fossum: Fs.					
Grail: GaA, GaB	---	Eastern redcedar, Rocky Mt. juniper, Siberian peashrub, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce.	Siberian elm	Eastern cottonwood.
Grano: Gn.					
Grassna: GoA	---	Eastern redcedar, Rocky Mt. juniper, Siberian peashrub, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce.	Siberian elm	Eastern cottonwood.
Hamerly: HaA	---	Eastern redcedar, American plum, common chokecherry, Siberian peashrub.	Ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm, American elm, green ash.	Eastern cottonwood.
Harriet: [1] Hk: Harriet part. Saline land part.					
Havrelon: Hn, Ho	---	Siberian peashrub, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce, common chokecherry, eastern redcedar.	Siberian elm	Eastern cottonwood.

TABLE 3.—*Windbreaks and environmental plantings*—Continued

Soil and map symbol	Trees having predicted 20-year average heights, in feet, of—				
	<8	8–15	16–25	26–35	>35
Heil: Hs.					
Krem: KrB	American plum, common choke-cherry, lilac, Tatarian honey-suckle.	Green ash, Russian-olive, Siberian pea-shrub.	Siberian elm, ponderosa pine.		
Lallie: La.					
Lihen: LeB, LeC		Ponderosa pine, eastern redcedar, Rocky Mt. juniper.			
[1] LgE: Lihen part					
Zahl part.					
Linton: [1] LmB: Linton part		Russian-olive, Siberian pea-shrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	
Mandan part		Russian-olive, Siberian pea-shrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	
[1] LmC: Linton part		Russian-olive, Siberian pea-shrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	
Mandan part		Russian-olive, Siberian pea-shrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	

TABLE 3.—*Windbreaks and environmental plantings*—Continued

Soil and map symbol	Trees having predicted 20-year average heights, in feet, of—				
	<8	8–15	16–25	26–35	>35
[1] LmD:					
Linton part	----	Russian-olive, Siberian pea-shrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	----
Mandan part	----	Russian-olive, Siberian pea-shrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	----
LmE:					
Linton part.					
Mandan part.					
Lohler:					
Lw, Ly	----	Siberian peashrub, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce, common chokecherry, eastern redcedar.	Siberian elm	Eastern cottonwood.
Makoti:					
Ma	----	Eastern redcedar, Russian-olive, Siberian pea-shrub, Tatarian honeysuckle, American plum.	American elm, Black Hills spruce, blue spruce, green ash, ponderosa pine.	Siberian elm	Eastern cottonwood.
Mandan:					
MdA, MdB, MdC	----	Russian-olive, Siberian pea-shrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	----
Marysland:					
Mf	----	Tatarian honey-suckle, Siberian peashrub.	Russian-olive	Green ash	Eastern cottonwood, golden willow, Siberian elm.
Max:					
MgB	----	Russian-olive, Siberian pea-shrub, common chokecherry, eastern redcedar, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	Siberian elm, American elm, green ash, ponderosa pine.	----	----

TABLE 3.—*Windbreaks and environmental plantings*—Continued

Soil and map symbol	Trees having predicted 20-year average heights, in feet, of— <8	8–15	16–25	26–35	>35
[1] MhC:					
Max part	----------	Russian-olive, Siberian pea-shrub, common chokecherry, eastern redcedar, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	Siberian elm, American elm, green ash, ponderosa pine.	----------	----------
Bowbells part	----------	Eastern redcedar, American plum, common choke-cherry, Siberian peashrub.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm	Eastern cottonwood.
Zahl part	Siberian pea-shrub.	Ponderosa pine, Siberian elm, green ash, Russian-olive, eastern redcedar, Rocky Mt. juniper.	----------	----------	----------
[1] MlC:					
Max part	----------	Russian-olive, Siberian pea-shrub, common chokecherry, eastern redcedar, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	Siberian elm, American elm, green ash, ponderosa pine.	----------	----------
Zahl part	Siberian pea-shrub.	Ponderosa pine, Siberian elm, green ash, Russian-olive, eastern redcedar, Rocky Mt. juniper.	----------	----------	----------
[1] MlD:					
Max part	----------	Russian-olive, Siberian pea-shrub, common chokecherry, eastern redcedar, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	Siberian elm, American elm, green ash, ponderosa pine.	----------	----------
Zahl part	Siberian pea-shrub.	Ponderosa pine, Siberian elm, green ash, Russian-olive, eastern redcedar, Rocky Mt. juniper.	----------	----------	----------

TABLE 3.—*Windbreaks and environmental plantings*—Continued

Soil and map symbol	Trees having predicted 20-year average heights, in feet, of—				
	<8	8–15	16–25	26–35	>35
Morton:					
MoC		Russian-olive, Siberian pea-shrub, common chokecherry, eastern redcedar, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	
Niobell:					
[1] NbA:					
Niobell part		Eastern redcedar, Rocky Mt. juniper, Russian-olive, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	Siberian elm, green ash, American elm, ponderosa pine.		
Williams part		Eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Siberian pea-shrub, common chokecherry, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine.	Siberian elm	
[1] NbB:					
Niobell part		Eastern redcedar, Rocky Mt. juniper, Russian-olive, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	Siberian elm, green ash, American elm, ponderosa pine.		
Williams part		Eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Siberian pea-shrub, common chokecherry, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine.	Siberian elm	
Noonan:					
[1] NmB:					
Noonan part.					
Miranda part.					
[1] NmD:					
Noonan part.					
Miranda part.					

TABLE 3.—*Windbreaks and environmental plantings*—Continued

Soil and map symbol	Trees having predicted 20-year average heights, in feet, of— <8	8–15	16–25	26–35	>35
Nutley: NtA, NtB	Peking cotoneaster, lilac.	Siberian crab-apple, common chokecherry, American plum, silver buffalo-berry, Siberian peashrub.	Green ash, hack-berry, ponderosa pine, Russian-olive, eastern redcedar.		
Orthents: Or.					
Parnell: Pa, Pe.					
Parshall: PhA, PhB, PhC, PhD, PoA, PoB		Siberian peashrub, Tatarian honeysuckle, American plum.	American elm, blue spruce, green ash, ponderosa pine, common chokecherry, Rocky Mt. juniper, Russian-olive.	Siberian elm	Eastern cottonwood.
Regent: RgC		Russian-olive, Siberian pea-shrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle.	Siberian elm, American elm, green ash.		
Rhoades: [1] RhB.					
Riverwash: Rm.					
Roseglen: Ro		Siberian peashrub, Tatarian honeysuckle, American plum.	American elm, blue spruce, green ash, ponderosa pine, common chokecherry, eastern redcedar, Russian-olive.	Siberian elm	Eastern cottonwood.
[1] RpB: Roseglen part		Siberian peashrub, Tatarian honeysuckle, American plum.	American elm, blue spruce, green ash, ponderosa pine, common chokecherry, eastern redcedar, Russian-olive.	Siberian elm	Eastern cottonwood.
Tansem part		Russian-olive, Siberian pea-shrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	

TABLE 3.—*Windbreaks and environmental plantings*—Continued

Soil and map symbol	Trees having predicted 20-year average heights, in feet, of—				
	<8	8–15	16–25	26–35	>35
[1] RpC:					
Roseglen part		Siberian peashrub, Tatarian honeysuckle, American plum.	American elm, blue spruce, green ash, ponderosa pine, common chokecherry, eastern redcedar, Russian-olive.	Siberian elm	Eastern cottonwood.
Tansem part		Russian-olive, Siberian peashrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	
Ruso:					
RsA, RzA		Green ash, ponderosa pine, Russian-olive, Siberian peashrub, eastern redcedar.	Siberian elm		
[1] RtB:					
Ruso part		Green ash, ponderosa pine, Russian-olive, Siberian peashrub, eastern redcedar.	Siberian elm		
Manning part	Siberian peashrub, eastern redcedar, Rocky Mt. juniper.	Green ash, ponderosa pine, Russian-olive.	Siberian elm		
[1] RtC:					
Ruso part		Green ash, ponderosa pine, Russian-olive, Siberian peashrub, eastern redcedar.	Siberian elm		
Manning part	Siberian peashrub, eastern redcedar, Rocky Mt. juniper.	Green ash, ponderosa pine, Russian-olive.	Siberian elm		
[1] RxB:					
Ruso part		Green ash, ponderosa pine, Russian-olive, Siberian peashrub, eastern redcedar.	Siberian elm		
Manning part	Siberian peashrub, eastern redcedar, Rocky Mt. juniper.	Green ash, ponderosa pine, Russian-olive.	Siberian elm		
[1] RyC:					
Ruso part		Green ash, ponderosa pine, Russian-olive, Siberian peashrub, eastern redcedar.	Siberian elm		

TABLE 3.—*Windbreaks and environmental plantings*—Continued

Soil and map symbol	Trees having predicted 20-year average heights, in feet, of—				
	<8	8–15	16–25	26–35	>35
Wabek part.					
Seroco: SeD.					
Sinai: Sn	Peking cotoneaster, lilac.	Siberian crab-apple, common chokecherry, American plum, silver buffalo-berry, Siberian peashrub.	Green ash, hack-berry, ponderosa pine, Russian-olive, eastern redcedar.		
Straw: St, Sx		Siberian peashrub, Tatarian honeysuckle, American plum.	American elm, blue spruce, green ash, ponderosa pine, common chokecherry, eastern redcedar, Russian-olive.	Siberian elm	Eastern cottonwood.
Telfer: [1] TlC: Telfer part		Ponderosa pine, eastern redcedar, Rocky Mt. juniper.			
Lihen part		Ponderosa pine, eastern redcedar, Rocky Mt. juniper.			
Tonka: [1] Tp: Tonka part.					
Parnell part.					
Trembles: Tr		Siberian peashrub, Tatarian honeysuckle, American plum.	American elm, blue spruce, green ash, ponderosa pine, common chokecherry, Rocky Mt. juniper, Russian-olive.	Siberian elm	Eastern cottonwood.
Vebar: [1] VwC: Vebar part		American elm, green ash, Siberian pea-shrub, eastern redcedar, common choke-cherry, American plum.	Siberian elm, ponderosa pine.		
Williams part		Eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Siberian pea-shrub, common chokecherry, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine.	Siberian elm	

TABLE 3.—*Windbreaks and environmental plantings*—Continued

Soil and map symbol	Trees having predicted 20-year average heights, in feet, of—				
	<8	8-15	16-25	26-35	>35
Wabek:					
[1] WaB:					
Wabek part.					
Max part	---	Russian-olive, Siberian pea-shrub, common chokecherry, eastern redcedar, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	Siberian elm, American elm, green ash, ponderosa pine.	---	---
Zahl part	Siberian pea-shrub.	Ponderosa pine, Siberian elm, green ash, Russian-olive, eastern redcedar, Rocky Mt. juniper.	---	---	---
[1] WaD:					
Wabek part.					
Max part	---	Russian-olive, Siberian pea-shrub, common chokecherry, eastern redcedar, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	Siberian elm, American elm, green ash, ponderosa pine.	---	---
Zahl part	Siberian pea-shrub.	Ponderosa pine, Siberian elm, green ash, Russian-olive, eastern redcedar, Rocky Mt. juniper.	---	---	---
[1] WbB, [1] WbD.					
Williams:					
WlB, WmA, WmB, WrB	---	Eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Siberian pea-shrub, common chokecherry, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine.	Siberian elm	---
[1] WoA:					
Williams part	---	Eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Siberian pea-shrub, common chokecherry, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine.	Siberian elm	---

TABLE 3.—*Windbreaks and environmental plantings*—Continued

Soil and map symbol	Trees having predicted 20-year average heights, in feet, of—				
	<8	8-15	16-25	26-35	>35
Bowbells part		Eastern redcedar, American plum, common chokecherry, Siberian peashrub.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm	Eastern cottonwood.
[1] WoB: Williams part		Eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine.	Siberian elm	
Bowbells part		Eastern redcedar, American plum, common chokecherry, Siberian peashrub.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm	Eastern cottonwood.
[1] WoC: Williams part		Eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine.	Siberian elm	
Bowbells part		Eastern redcedar, American plum, common chokecherry, Siberian peashrub.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm	Eastern cottonwood.
[1] WpB: Williams part		Eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Siberian peashrub, common chokecherry, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine.	Siberian elm	
Bowbells part		Eastern redcedar, American plum, common chokecherry, Siberian peashrub.	American elm, green ash, ponderosa pine, Black Hills spruce, blue spruce, Russian-olive.	Siberian elm	Eastern cottonwood.

TABLE 3.—*Windbreaks and environmental plantings*—Continued

Soil and map symbol	Trees having predicted 20-year average heights, in feet, of –				
	<8	8–15	16–25	26–35	>35
Zahl part	Siberian pea-shrub.	Ponderosa pine, Siberian elm, green ash, Russian-olive, eastern redcedar, Rocky Mt. juniper.	---	---	---
Wilton:					
WsA	---	Russian-olive, Siberian pea-shrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	---
[1] WtB:					
Wilton part	---	Russian-olive, Siberian pea-shrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	---
Temvik part	---	Russian-olive, Siberian pea-shrub, eastern redcedar, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	---
[1] WwC:					
Wilton part	---	Russian-olive, Siberian pea-shrub, common chokecherry, Rocky Mt. juniper, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine, blue spruce.	Siberian elm	---
Williams part	---	Eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Siberian pea-shrub, common chokecherry, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine.	Siberian elm	---
Zahl:					
[1] ZcE:					
Zahl part.					
Cabba part.					

TABLE 3.—*Windbreaks and environmental plantings*—Continued

Soil and map symbol	Trees having predicted 20-year average heights, in feet, of—				
	<8	8–15	16–25	26–35	>35
[1] ZmE: Zahl part.					
Max part.					
[1] ZpE: Zahl part.					
Max part.					
Parnell part.					
[1] ZwC: Zahl part	Siberian pea-shrub.	Ponderosa pine, Siberian elm, green ash, Russian-olive, eastern redcedar, Rocky Mt. juniper.			
Williams part		Eastern redcedar, Rocky Mt. juniper, blue spruce, Black Hills spruce, Siberian pea-shrub, common chokecherry, Tatarian honeysuckle, American plum.	American elm, green ash, ponderosa pine.	Siberian elm	

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

have taken place in the plant community. More important, however, range condition is a basis for predicting the kind and amount of change in the present plant community that can be expected under specified management. Thus, the range condition rating indicates the nature of the present plant community, and the climax cover for the range site represents a goal toward which range management can be directed.

Knowledge of the climax plant community and the present plant community as related to the climax is important in planning range management. Such information is the basis for selecting management goals, designing grazing systems, managing for wildlife, determining potential for recreation, and rating watershed conditions.

Any management objective on rangeland should provide for a plant cover that adequately protects or improves the soil and water resource and meets the needs of the operator. The management usually involves maintaining or increasing desirable plants and restoring the plant community to near climax condition where it has deteriorated. Sometimes, however, a plant cover somewhat below climax will better suit specific grazing needs, provide better wildlife habitat, or furnish other benefits while still protecting the soil and water resource.

Table 4 shows, for each kind of soil, the range site name, the potential total annual production of all plant species in favorable, normal, and unfavorable years, and the names of major plant species and their percentage composition in the potential plant community.

Potential production refers to the total annual production of all plant species that can be expected from well managed rangeland supporting the potential plant community. It is expressed in pounds per acre of air-dry yield for favorable, normal, and unfavorable growing conditions, or kinds of years. A favorable year is one in which the amount and distribution of precipitation and the temperatures result in growing conditions substantially better than average; a normal year is one in which these conditions are about average for the area; and an unfavorable year is one in which growing conditions are well below normal generally because of low available soil moisture.

Dry weight refers to the total air-dry weight of plant species produced by the soil each year under good grazing management. Included are plants that are highly palatable, as well as some that are unpalatable or not grazed by livestock. Likewise, some of the plants are grazed extensively by wildlife species while some are not.

Common plant names are listed for those species that comprise the bulk of the potential plant com-

TABLE 4.—*Range productivity and composition*

[Soils not classified as a range site can be used for grazing if grass cover is established]

Soil and map symbol	Range site	Potential production		Common plant name	Composition
		Kind of year	Dry weight		
			Lbs/ac		*Pct*
Aquents:					
Ac	Not classified.				
Aquolls:					
Af	Not classified.				
Arnegard:					
ArA	Overflow.	Favorable	3,200	Big bluestem	20
		Normal	2,800	Western wheatgrass	20
		Unfavorable	2,400	Green needlegrass	15
				Needleandthread	7
				Blue grama	5
				Kentucky bluegrass	5
ArB, ArC	Silty.	Favorable	2,550	Western wheatgrass	25
		Normal	2,150	Needleandthread	15
		Unfavorable	1,750	Blue grama	13
				Green needlegrass	10
				Kentucky bluegrass	5
Banks:					
Ba, Bk	Not classified.				
Bowbells:					
BoA	Overflow.	Favorable	3,350	Western wheatgrass	10
		Normal	2,900	Needleandthread	10
		Unfavorable	2,450	Green needlegrass	15
				Big bluestem	25
				Kentucky bluegrass	5
				Porcupinegrass	5
[1] BsB:					
Bowbells part	Silty.	Favorable	2,800	Western wheatgrass	25
		Normal	2,400	Needleandthread	15
		Unfavorable	2,000	Green needlegrass	10
				Blue grama	10
				Kentucky bluegrass	5
				Penn sedge	5
Williams part	Silty.	Favorable	2,350	Western wheatgrass	25
		Normal	1,950	Needleandthread	15
		Unfavorable	1,550	Green needlegrass	7
				Prairie junegrass	5
				Blue grama	13
				Kentucky bluegrass	5
				Other perennial grasses	5
Bowdle:					
BwA	Silty.	Favorable	2,880	Green needlegrass	30
		Normal	2,400	Western wheatgrass	25
		Unfavorable	1,680	Needleandthread	25
				Blue grama	10
[1] ByB, [1] ByC:					
Bowdle part	Silty.	Favorable	2,880	Green needlegrass	30
		Normal	2 400	Western wheatgrass	25
		Unfavorable	1,680	Needleandthread	25
				Blue grama	10
Stady part	Silty.	Favorable	2,000	Western wheatgrass	25
		Normal	1,700	Needleandthread	15
		Unfavorable	1,400	Green needlegrass	7
				Prairie junegrass	5
				Blue grama	13
				Kentucky bluegrass	5

TABLE 4.—*Range productivity and composition*—Continued

Soil and map symbol	Range site	Potential production		Common plant name	Composition
		Kind of year	Dry weight		
			Lbs/ac		*Pct*
Cabba:					
[1] CaE:	Shallow.	Favorable	1,700	Little bluestem	20
		Normal	1,400	Western wheatgrass	20
		Unfavorable	1,150	Prairie sandreed	10
				Needleandthread	10
				Green needlegrass	5
				Plains muhly	5
				Bluebunch wheatgrass	5
Cabba:					
[1] CbF:					
Cabba part	Shallow.	Favorable	1,700	Little bluestem	20
		Normal	1,400	Western wheatgrass	20
		Unfavorable	1,150	Prairie sandreed	10
				Needleandthread	10
				Green needlegrass	5
				Plains muhly	5
				Bluebunch wheatgrass	5
Shale outcrop part	Not classified.				
Cohagen:					
[1] ChD, [1] ChE:					
Cohagen part	Shallow.	Favorable	1,700	Little bluestem	25
		Normal	1,400	Needleandthread	10
		Unfavorable	1,100	Prairie sandreed	10
				Threadleaf sedge	8
				Plains muhly	5
				Blue grama	5
				Western wheatgrass	5
Vebar part	Sandy.	Favorable	2,300	Needleandthread	25
		Normal	2,000	Prairie sandreed	15
		Unfavorable	1,700	Western wheatgrass	10
				Blue grama	10
				Prairie junegrass	5
				Penn sedge	10
Colvin:					
Co	Wet meadow.	Favorable	5,900	Slim sedge	70
		Normal	4,950	Northern reedgrass	5
		Unfavorable	4,000	Prairie cordgrass	5
Dimmick:					
Dm	Wetland.	Favorable	5,650	Slough sedge	35
		Normal	5,200	Rivergrass	30
		Unfavorable	4,750	Prairie cordgrass	5
				Slim sedge	5
Divide:					
Dv	Silty.	Favorable	2,600	Western wheatgrass	25
		Normal	2,200	Green needlegrass	7
		Unfavorable	1,800	Needleandthread	15
				Kentucky bluegrass	5
				Blue grama	13
Falkirk:					
FaA, FaB	Silty.	Favorable	2,550	Western wheatgrass	20
		Normal	2.150	Needleandthread	15
		Unfavorable	1,750	Green needlegrass	10
				Prairie junegrass	10
				Blue grama	10
				Kentucky bluegrass	5
				Penn sedge	5

TABLE 4.—*Range productivity and composition*—Continued

Soil and map symbol	Range site	Potential production		Common plant name	Composition
		Kind of year	Dry weight		
			Lbs/ac		*Pct*
[1] FbA, [1] FbB, [1] FbC: Falkirk part	Silty.	Favorable	2,550	Western wheatgrass	20
		Normal	2,150	Needleandthread	15
		Unfavorable	1,750	Green needlegrass	10
				Prairie junegrass	10
				Blue grama	10
				Kentucky bluegrass	5
				Penn sedge	5
Max part	Silty.	Favorable	2,650	Western wheatgrass	20
		Normal	2,250	Needleandthread	15
		Unfavorable	1,850	Green needlegrass	10
				Prairie junegrass	10
				Blue grama	10
				Kentucky bluegrass	5
				Penn sedge	5
Farnuf: FfA, FfB	Silty.	Favorable	2,550	Western wheatgrass	45
		Normal	2,150	Needleandthread	20
		Unfavorable	1,750	Green needlegrass	5
				Little bluestem	5
				Prairie sandreed	5
				Blue grama	5
Flasher: FlD, FlE	Shallow.	Favorable	1,700	Little bluestem	25
		Normal	1,400	Prairie sandreed	10
		Unfavorable	1,100	Needleandthread	10
				Threadleaf sedge	8
				Plains muhly	5
				Western wheatgrass	5
				Blue grama	5
Flaxton: FnA, FnB, FnC	Sandy.	Favorable	2,800	Needleandthread	25
		Normal	2,400	Prairie sandreed	15
		Unfavorable	2,000	Western wheatgrass	10
				Penn sedge	10
				Blue grama	5
				Prairie junegrass	5
Fossum: Fs	Wet meadow.	Favorable	5,000	Big bluestem	30
		Normal	3,800	Indiangrass	20
		Unfavorable	3,400	Switchgrass	10
				Prairie cordgrass	10
				Reed canarygrass	10
Grail: GaA	Overflow.	Favorable	3,300	Big bluestem	25
		Normal	2,900	Green needlegrass	15
		Unfavorable	2,500	Western wheatgrass	10
				Needleandthread	10
				Kentucky bluegrass	5
GaB	Silty.	Favorable	2,750	Western wheatgrass	20
		Normal	2,350	Needleandthread	15
		Unfavorable	1,950	Green needlegrass	10
				Blue grama	10
				Prairie junegrass	10
				Kentucky bluegrass	5
				Penn sedge	5
Grano: Gn	Wetland.	Favorable	6,800	Slough sedge	35
		Normal	6.000	Woolly sedge	10
		Unfavorable	5,500	Slim sedge	5
				Rivergrass	30

TABLE 4.—*Range productivity and composition*—Continued

Soil and map symbol	Range site	Potential production		Common plant name	Compo-sition
		Kind of year	Dry weight		
			Lbs/ac		*Pct*
Grassna:					
GoA	Overflow.	Favorable	3,300	Big bluestem	25
		Normal	2,900	Green needlegrass	15
		Unfavorable	2,500	Western wheatgrass	10
				Needleandthread	10
				Kentucky bluegrass	5
Hamerly:					
HaA	Silty.	Favorable	2,300	Western wheatgrass	10
		Normal	2,000	Streambank wheatgrass	5
		Unfavorable	1,700	Green needlegrass	10
				Porcupinegrass	10
				Needleandthread	15
				Kentucky bluegrass	10
				Blue grama	5
				Bearded wheatgrass	5
				Penn sedge	5
Harriet:					
[1] Hk:					
Harriet part	Saline lowland.	Favorable	2,600	Nuttall alkaligrass	15
		Normal	2,200	Western wheatgrass	35
		Unfavorable	1,800	Slender wheatgrass	5
				Inland saltgrass	20
Saline land part	Not classified.				
Havrelon:					
Hn, Ho	Not classified.				
Heil:					
Hs	Closed depression.	Favorable	3,000	Western wheatgrass	40
		Normal	2,600	Prairie cordgrass	15
		Unfavorable	2,200	Common spikesedge	10
				Kentucky bluegrass	5
				Inland saltgrass	5
Krem:					
KrB	Sands.	Favorable	2,650	Needleandthread	25
		Normal	2,300	Prairie sandreed	15
		Unfavorable	1,950	Western wheatgrass	10
				Penn sedge	10
				Blue grama	5
				Prairie junegrass	5
				Kentucky bluegrass	5
				Threadleaf sedge	5
Lallie:					
La	Wetland.	Favorable	6,050	Slough sedge	35
		Normal	5,300	Rivergrass	30
		Unfavorable	4,550	Prairie cordgrass	5
				Slim sedge	5
Lihen:					
LeB, LeC	Sands.	Favorable	2,600	Prairie sandreed	30
		Normal	2,200	Little bluestem	28
		Unfavorable	1,800	Sand bluestem	10
				Big bluestem	5
				Needleandthread	5
[1] LgE:					
Lihen part	Sands.	Favorable	2,600	Prairie sandreed	30
		Normal	2,200	Little bluestem	28
		Unfavorable	1,800	Sand bluestem	10
				Big bluestem	5
				Needleandthread	5

TABLE 4.—*Range productivity and composition*—Continued

Soil and map symbol	Range site	Potential production		Common plant name	Composition
		Kind of year	Dry weight		
			Lbs/ac		*Pct*
Zahl part	Thin upland.	Favorable	2,300	Little bluestem	20
		Normal	1,900	Western wheatgrass	10
		Unfavorable	1,500	Needleandthread	10
				Sideoats grama	5
				Plains muhly	5
				Porcupinegrass	5
				Blue grama	5
				Penn sedge	8
Linton:					
[1] LmB, [1] LmC, [1] LmD, [1] LmE:					
Linton part	Silty.	Favorable	2,550	Western wheatgrass	20
		Normal	2,200	Needleandthread	15
		Unfavorable	1,850	Green needlegrass	10
				Prairie junegrass	10
				Blue grama	10
				Penn sedge	5
Mandan part	Silty.	Favorable	2,350	Western wheatgrass	25
		Normal	2,050	Needleandthread	15
		Unfavorable	1,750	Blue grama	13
				Green needlegrass	7
				Prairie junegrass	5
Lohler:					
Lw, Ly	Not classified.				
Makoti:					
Ma	Silty.	Favorable	2,550	Western wheatgrass	20
		Normal	2,150	Needleandthread	15
		Unfavorable	1,750	Green needlegrass	10
				Prairie junegrass	10
				Blue grama	10
				Kentucky bluegrass	5
				Penn sedge	5
Mandan:					
MdA, MdB, MdC	Silty.	Favorable	2,350	Western wheatgrass	25
		Normal	2,050	Needleandthread	15
		Unfavorable	1,750	Blue grama	13
				Green needlegrass	7
				Prairie junegrass	5
Marysland:					
Mf	Wet meadow.	Favorable	6,400	Big bluestem	30
		Normal	5,800	Indiangrass	20
		Unfavorable	5,200	Switchgrass	10
				Prairie cordgrass	10
				Reed canarygrass	10
Max:					
MgB	Silty.	Favorable	2,650	Western wheatgrass	20
		Normal	2,250	Needleandthread	15
		Unfavorable	1,850	Green needlegrass	10
				Blue grama	10
				Prairie junegrass	10
				Kentucky bluegrass	5
				Penn sedge	5
[1] MhC:					
Max part	Silty.	Favorable	2,650	Western wheatgrass	20
		Normal	2,250	Needleandthread	15
		Unfavorable	1,850	Green needlegrass	10
				Prairie junegrass	10
				Blue grama	10
				Kentucky bluegrass	5
				Penn sedge	5

TABLE 4.—*Range productivity and composition*—Continued

Soil and map symbol	Range site	Potential production		Common plant name	Composition
		Kind of year	Dry weight		
			Lbs/ac		*Pct*
Bowbells part	Silty.	Favorable	2,800	Western wheatgrass	25
		Normal	2,400	Needleandthread	15
		Unfavorable	2,000	Green needlegrass	10
				Blue grama	10
				Kentucky bluegrass	5
				Penn sedge	5
Zahl part	Thin upland.	Favorable	2,300	Little bluestem	20
		Normal	1,900	Western wheatgrass	10
		Unfavorable	1,500	Needleandthread	10
				Sideoats grama	5
				Plains muhly	5
				Porcupinegrass	5
				Blue grama	5
				Penn sedge	8
[1] MlC, [1] MlD:					
Max part	Silty.	Favorable	2,650	Western wheatgrass	20
		Normal	2,250	Needleandthread	15
		Unfavorable	1,850	Green needlegrass	10
				Prairie junegrass	10
				Blue grama	10
				Kentucky bluegrass	5
				Penn sedge	5
Zahl part	Thin upland.	Favorable	2,300	Little bluestem	20
		Normal	1,900	Western wheatgrass	10
		Unfavorable	1,500	Needleandthread	10
				Sideoats grama	5
				Plains muhly	5
				Porcupinegrass	5
				Blue grama	5
				Penn sedge	8
Morton:					
MoC	Silty.	Favorable	2,300	Western wheatgrass	25
		Normal	1,900	Needleandthread	15
		Unfavorable	1,500	Green needlegrass	7
				Prairie junegrass	5
				Blue grama	13
				Kentucky bluegrass	5
Niobell:					
[1] NbA, [1] NbB:					
Niobell part	Clayey.	Favorable	2,550	Western wheatgrass	40
		Normal	2,150	Green needlegrass	10
		Unfavorable	1,750	Needleandthread	5
				Blue grama	10
				Kentucky bluegrass	7
Williams part	Silty.	Favorable	2,350	Western wheatgrass	25
		Normal	1,950	Needleandthread	15
		Unfavorable	1,550	Green needlegrass	7
				Prairie junegrass	5
				Blue grama	13
				Kentucky bluegrass	5
Noonan:					
[1] NmB, [1] NmD:					
Noonan part	Claypan.	Favorable	2,000	Western wheatgrass	40
		Normal	1,650	Green needlegrass	5
		Unfavorable	1,200	Needleandthread	5
				Blue grama	20
				Prairie junegrass	5
				Penn sedge	5

TABLE 4.—*Range productivity and composition*—Continued

Soil and map symbol	Range site	Potential production		Common plant name	Composition
		Kind of year	Dry weight		
			Lbs/ac		*Pct*
Miranda part	Thin claypan.	Favorable	1,680	Blue grama	30
		Normal	1,400	Western wheatgrass	15
		Unfavorable	840	Buffalograss	10
				Needleandthread	5
				Saltgrass	5
				Pricklypear	5
Nutley: NtA, NtB	Clayey.	Favorable	2,100	Green needlegrass	35
		Normal	1,800	Western wheatgrass	30
		Unfavorable	1,550	Little bluestem	5
				Sideoats grama	10
				Blue grama	10
Orthents: Or	Not classified.				
Parnell: Pa, Pe	Wetland.	Favorable	5,700	Prairie cordgrass	30
		Normal	5,200	Northern reedgrass	20
		Unfavorable	4,800	Reed canarygrass	20
				Slough sedge	10
					5
Parshall: PhA, PhB, PhC, PhD, PoA, PoB	Sandy.	Favorable	2,600	Prairie sandreed	15
		Normal	2,200	Needleandthread	20
		Unfavorable	1,800	Western wheatgrass	10
				Prairie junegrass	5
				Blue grama	10
				Penn sedge	10
Regent: RgC	Clayey.	Favorable	2,150	Western wheatgrass	40
		Normal	1,800	Green needlegrass	10
		Unfavorable	1,450	Blue grama	10
				Prairie junegrass	5
				Plains reedgrass	5
Rhoades: [1] RhB	Thin claypan.	Favorable	800	Western wheatgrass	35
		Normal	600	Blue grama	30
		Unfavorable	400	Sandberg bluegrass	5
				Prairie junegrass	5
Riverwash: Rm	Not classified.				
Roseglen: Ro	Silty.	Favorable	2,700	Western wheatgrass	25
		Normal	2,300	Needleandthread	15
		Unfavorable	1,900	Green needlegrass	10
				Porcupinegrass	5
				Blue grama	10
				Kentucky bluegrass	5
				Penn sedge	5
[1] RpB, [1] RpC: Roseglen part	Silty.	Favorable	2,700	Western wheatgrass	25
		Normal	2,300	Needleandthread	15
		Unfavorable	1,900	Green needlegrass	10
				Porcupinegrass	5
				Blue grama	10
				Kentucky bluegrass	5
				Penn sedge	5

TABLE 4.—*Range productivity and composition*—Continued

Soil and map symbol	Range site	Potential production		Common plant name	Composition
		Kind of year	Dry weight		
			Lbs/ac		*Pct*
Tansem part	Silty.	Favorable	2,550	Western wheatgrass	25
		Normal	2,150	Needleandthread	15
		Unfavorable	1,750	Green needlegrass	10
				Porcupinegrass	5
				Blue grama	10
				Kentucky bluegrass	5
				Penn sedge	5
Ruso:					
RsA, RzA	Sandy.	Favorable	2,400	Needleandthread	30
		Normal	2,100	Prairie sandreed	12
		Unfavorable	1,800	Western wheatgrass	10
				Penn sedge	10
				Blue grama	7
				Threadleaf sedge	5
[1] RtB, [1] RtC, [1] RxB:					
Ruso part	Sandy.	Favorable	2,400	Needleandthread	30
		Normal	2,100	Prairie sandreed	12
		Unfavorable	1,800	Western wheatgrass	10
				Penn sedge	10
				Blue grama	7
				Threadleaf sedge	5
Manning part	Sandy.	Favorable	2,150	Needleandthread	20
		Normal	1,800	Prairie sandreed	20
		Unfavorable	1,450	Blue grama	10
				Western wheatgrass	10
				Prairie junegrass	5
				Green needlegrass	5
				Penn sedge	6
[1] RvC:					
Ruso part	Sandy.	Favorable	2,400	Needleandthread	30
		Normal	2,100	Prairie sandreed	12
		Unfavorable	1,800	Western wheatgrass	10
				Penn sedge	10
				Blue grama	7
Wabek part	Very shallow.	Favorable	800	Needleandthread	25
		Normal	700	Blue grama	15
		Unfavorable	600	Plains muhly	5
				Western wheatgrass	15
				Prairie junegrass	5
				Red threeawn	5
				Threadleaf sedge	8
Seroco:					
SeD	Thin sands.	Favorable	1,800	Prairie sandreed	25
		Normal	1,500	Needleandthread	25
		Unfavorable	1,200	Sand dropseed	5
				Western wheatgrass	5
				Blue grama	7
				Penn sedge	10
Sinai:					
Sn	Clayey.	Favorable	2,100	Green needlegrass	35
		Normal	1,800	Western wheatgrass	30
		Unfavorable	1,500	Little bluestem	5
				Sideoats grama	10
				Blue grama	10
				Sedges	5

TABLE 4.—*Range productivity and composition*—Continued

Soil and map symbol	Range site	Potential production: Kind of year	Potential production: Dry weight	Common plant name	Composition
			Lbs/ac		*Pct*
Straw:					
St	Silty.	Favorable	2,250	Western wheatgrass	45
		Normal	1,950	Needleandthread	20
		Unfavorable	1,650	Green needlegrass	5
				Little bluestem	5
				Prairie sandreed	5
				Blue grama	5
[1] Sx	Overflow.	Favorable	3,000	Big bluestem	20
		Normal	2,600	Green needlegrass	15
		Unfavorable	2,200	Western wheatgrass	20
				Needleandthread	5
				Blue grama	5
Telfer:					
[1] TlC:					
Telfer part	Sands.	Favorable	2,500	Needleandthread	25
		Normal	2,100	Prairie sandreed	15
		Unfavorable	1,700	Western wheatgrass	5
				Blue grama	8
				Sand dropseed	5
				Sand bluestem	5
				Little bluestem	5
				Penn sedge	10
Lihen part	Sands.	Favorable	2,600	Prairie sandreed	30
		Normal	2,200	Little bluestem	28
		Unfavorable	1,800	Sand bluestem	10
				Big bluestem	5
				Needleandthread	5
Tonka:					
[1] Tp:					
Tonka part	Wet meadow.	Favorable	4,000	Slim sedge	25
		Normal	3,400	Woolly sedge	25
		Unfavorable	2,800	Fescue sedge	5
				Baltic rush	5
				Common spikesedge	5
				Northern reedgrass	5
				Prairie cordgrass	5
Parnell part	Wetland.	Favorable	5,700	Prairie cordgrass	30
		Normal	5,200	Northern reedgrass	20
		Unfavorable	4,800	Reed canarygrass	20
				Slough sedge	10
				Switchgrass	5
Trembles:					
Tr	Not classified.				
Vebar:					
[1] VwC:					
Vebar part	Sandy.	Favorable	2,300	Needleandthread	25
		Normal	2,000	Prairie sandreed	15
		Unfavorable	1,700	Western wheatgrass	10
				Blue grama	10
				Prairie junegrass	5
				Penn sedge	10
Williams part	Silty.	Favorable	2,350	Western wheatgrass	25
		Normal	1,950	Needleandthread	15
		Unfavorable	1,550	Green needlegrass	7
				Prairie junegrass	5
				Blue grama	13
				Kentucky bluegrass	5

TABLE 4.—*Range productivity and composition*—Continued

Soil and map symbol	Range site	Potential production		Common plant name	Composition
		Kind of year	Dry weight		
			Lbs/ac		*Pct*
Wabek:					
[1] WaB [1] WaD:					
Wabek part	Very shallow.	Favorable	800	Needleandthread	25
		Normal	700	Blue grama	15
		Unfavorable	600	Plains muhly	5
				Western wheatgrass	15
				Prairie junegrass	5
				Red threeawn	5
				Threadleaf sedge	8
Max part	Silty.	Favorable	2,650	Western wheatgrass	20
		Normal	2,250	Needleandthread	15
		Unfavorable	1,850	Green needlegrass	10
				Prairie junegrass	10
				Blue grama	10
				Kentucky bluegrass	5
				Penn sedge	5
Zahl part	Thin upland.	Favorable	2,300	Little bluestem	20
		Normal	1,900	Western wheatgrass	10
		Unfavorable	1,500	Needleandthread	10
				Sideoats grama	5
				Plains muhly	5
				Porcupinegrass	5
				Blue grama	5
				Penn sedge	8
[1] WbB, [1] WbD	Very shallow.	Favorable	800	Needleandthread	25
		Normal	700	Blue grama	15
		Unfavorable	600	Plains muhly	5
				Western wheatgrass	15
				Prairie junegrass	5
				Red threeawn	5
				Threadleaf sedge	7
Williams:					
WlB, WmA, WmB, WrB	Silty.	Favorable	2,350	Western wheatgrass	25
		Normal	1,950	Needleandthread	15
		Unfavorable	1,550	Green needlegrass	7
				Prairie junegrass	5
				Blue grama	13
				Kentucky bluegrass	5
				Other perennial grasses	5
[1] WoA, [1] WoB, [1] WoC:					
Williams part	Silty.	Favorable	2,350	Western wheatgrass	25
		Normal	1,950	Needleandthread	15
		Unfavorable	1,550	Green needlegrass	7
				Prairie junegrass	5
				Blue grama	13
				Kentucky bluegrass	5
Bowbells part	Overflow.	Favorable	2,800	Western wheatgrass	25
		Normal	2,400	Needleandthread	15
		Unfavorable	2,000	Green needlegrass	10
				Blue grama	10
				Kentucky bluegrass	5
				Penn sedge	5
[1] WpB:					
Williams part	Silty.	Favorable	2,350	Western wheatgrass	25
		Normal	1,950	Needleandthread	15
		Unfavorable	1,550	Green needlegrass	7
				Prairie junegrass	5
				Blue grama	13
				Kentucky bluegrass	5

TABLE 4.—*Range productivity and composition*—Continued

Soil and map symbol	Range site	Potential production: Kind of year	Potential production: Dry weight	Common plant name	Composition
			Lbs/ac		*Pct*
Bowbells part	Silty.	Favorable Normal Unfavorable	2,800 2,400 2,000	Western wheatgrass Needleandthread Green needlegrass Blue grama Kentucky bluegrass Penn sedge	25 15 10 10 5 5
Zahl part	Thin upland.	Favorable Normal Unfavorable	2,300 1,900 1,500	Little bluestem Western wheatgrass Needleandthread Sideoats grama Plains muhly Porcupinegrass Blue grama Penn sedge	20 10 10 5 5 5 5 8
Wilton: WsA	Silty.	Favorable Normal Unfavorable	2,700 2,300 1,900	Western wheatgrass Needleandthread Green needlegrass Prairie junegrass Blue grama Kentucky bluegrass Penn sedge	20 15 10 10 10 5 5
[1] WtB: Wilton part	Silty.	Favorable Normal Unfavorable	2,700 2,300 1,900	Western wheatgrass Needleandthread Green needlegrass Prairie junegrass Blue grama Kentucky bluegrass Penn sedge	20 15 10 10 10 5 5
Temvik part	Silty.	Favorable Normal Unfavorable	2,600 2,200 1,800	Western wheatgrass Needleandthread Green needlegrass Prairie junegrass Blue grama Kentucky bluegrass Penn sedge	20 15 10 10 10 5 5
[1] WwC: Wilton part	Silty.	Favorable Normal Unfavorable	2,700 2,300 1,900	Western wheatgrass Needleandthread Green needlegrass Prairie junegrass Blue grama Kentucky bluegrass Penn sedge	20 15 10 10 10 5 5
Williams part	Silty.	Favorable Normal Unfavorable	2,350 1,950 1,550	Western wheatgrass Needleandthread Green needlegrass Prairie junegrass Blue grama Kentucky bluegrass	25 15 7 5 13 5
Zahl: [1] ZcE: Zahl part	Thin upland.	Favorable Normal Unfavorable	2,300 1,900 1,500	Little bluestem Western wheatgrass Needleandthread Sideoats grama Plains muhly Porcupinegrass Blue grama Penn sedge	20 10 10 5 5 5 5 8

TABLE 4.—*Range productivity and composition*—Continued

Soil and map symbol	Range site	Potential production		Common plant name	Compo-sition
		Kind of year	Dry weight		
			Lbs/ac		*Pct*
Cabba part	Shallow.	Favorable	1,700	Little bluestem	20
		Normal	1,400	Western wheatgrass	20
		Unfavorable	1,150	Prairie sandreed	10
				Needleandthread	10
				Green needlegrass	5
				Plains muhly	5
				Bluebunch wheatgrass	5
[1]ZmE:					
Zahl part	Thin upland.	Favorable	2,300	Little bluestem	20
		Normal	1,900	Western wheatgrass	10
		Unfavorable	1,500	Needleandthread	10
				Sideoats grama	5
				Plains muhly	5
				Porcupinegrass	5
				Blue grama	5
				Penn sedge	8
Max part	Silty.	Favorable	2,650	Western wheatgrass	20
		Normal	2,250	Needleandthread	15
		Unfavorable	1,850	Green needlegrass	10
				Prairie junegrass	10
				Blue grama	10
				Kentucky bluegrass	5
				Penn sedge	5
[1]ZpE:					
Zahl part	Thin upland.	Favorable	2,300	Little bluestem	20
		Normal	1,900	Western wheatgrass	10
		Unfavorable	1,500	Needleandthread	10
				Sideoats grama	5
				Plains muhly	5
				Porcupinegrass	5
				Blue grama	5
				Penn sedge	8
Max part	Silty.	Favorable	2,650	Western wheatgrass	20
		Normal	2,250	Needleandthread	15
		Unfavorable	1,850	Green needlegrass	10
				Prairie junegrass	10
				Blue grama	10
				Kentucky bluegrass	5
				Penn sedge	5
Parnell part	Wetland.	Favorable	5,700	Prairie cordgrass	30
		Normal	5,200	Northern reedgrass	20
		Unfavorable	4,800	Reed canarygrass	20
				Slough sedge	10
				Switchgrass	5
[1]ZwC:					
Zahl part	Thin upland.	Favorable	2,300	Little bluestem	20
		Normal	1,900	Western wheatgrass	10
		Unfavorable	1,500	Needleandthread	10
				Sideoats grama	5
				Plains muhly	5
				Porcupinegrass	5
				Blue grama	5
				Penn sedge	8
Williams part	Silty.	Favorable	2,350	Western wheatgrass	25
		Normal	1,950	Needleandthread	15
		Unfavorable	1,550	Green needlegrass	7
				Prairie junegrass	5
				Blue grama	13
				Kentucky bluegrass	5

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

munity on well managed rangeland. These include grasses, forbs, and woody plants. Composition of each species or group is presented in terms of the percent of dry weight of the total annual production of all plant species. The proportion of this production that is useable as forage depends on the kinds of grazing animals. All of the production is normally not utilized.

Wildlife [5]

This section describes the wildlife of McLean County and the opportunities for hunting and fishing. Wildlife and fishery resources play a significant role in providing a stimulus for outdoor activities. These resources also contribute to the economy of the county.

Fish and wildlife numbers have been reduced substantially since presettlement. The species composition, however, is still somewhat similar. Habitat is available for a wide variety of species.

Birds, such as wild geese and sandhill cranes, have been replaced to some degree by farm game species, such as ring-necked pheasant and gray partridge. Mammals, such as the elk and bear, have not been replaced by other wild species.

The most important game species in the county are ducks, geese, pheasant, gray partridge, sharp-tailed grouse, and white-tailed deer. Mourning dove, cottontail rabbit, and fox squirrel are underutilized game species. The fur bearers, red fox, jackrabbit, mink, muskrat, and raccoon, provide income and an important source of winter outdoor recreation.

In 1970 about 3.5 percent of the statewide small game hunting was in McLean County. During the same year hunting in the county yielded less than 1 percent of the statewide harvest of sharp-tailed grouse, about 3.5 percent of the gray partridge, 4 percent of the pheasant, 5.5 percent of the cottontail rabbit, and less than 0.5 percent of the tree squirrel. McLean County ranks tenth in the State in waterfowl harvest, sixth in duck harvest, and eighteenth in goose harvest.

The annual harvest of antelope is less than 50, and the annual harvest of white-tailed deer averages more than 500.

Fishing waters are plentiful in McLean County. Fish are abundant in Lake Sakakawea, Lake Audubon, and the Missouri River. Fishing is also provided in other lakes, such as Strawberry Lake, Crooked Lake, Brush Lake, and in artificial impoundments, such as Yanktonai Dam, Raub Dam, and Conklin Dam. Access is excellent to most of these fishing waters.

A number of private farm ponds are used for fishing in the county. There is some potential for additional private ponds.

The most commonly sought fish are northern pike, walleye, trout, catfish, bass, bluegills, perch, and bullheads.

Soils directly affect the kind and amount of vegetation that is available to wildlife as food and cover, and they affect the development of water impoundments. The kind and abundance of wildlife that populates an area depend largely on the amount and distribution of food, cover, and water. If any one of these elements is missing, inadequate, or inaccessible, wildlife will either be scarce or will not inhabit the area.

If the soils have the potential, wildlife habitat can be created or improved by planting appropriate vegetation, by properly managing the existing plant cover, and by fostering the natural establishment of desirable plants.

In table 5 the soils in the survey area are rated according to their potential to support the main kinds of wildlife habitat in the area. This information can be used in (1) planning for parks, wildlife refuges, nature study areas, and other developments for wildlife; (2) selecting soils that are suitable for creating, improving, or maintaining specific elements of wildlife habitat; (3) determining the intensity of management needed for each element of the habitat; and (4) determining areas that are suitable for acquisition to manage for wildlife.

The potential of the soil is rated good, fair, poor, or very poor. A rating of *good* means that the element of wildlife habitat or the kind of habitat is easily created, improved, or maintained. Few or no limitations affect management, and satisfactory results can be expected if the soil is used for the designated purpose. A rating of *fair* means that the element of wildlife habitat or kind of habitat can be created, improved, or maintained in most places. Moderate intensity of management and fairly frequent attention are required for satisfactory results. A rating of *poor* means that limitations are severe for the designated element or kind of wildlife habitat. Habitat can be created, improved, or maintained in most places, but management is difficult and requires intensive effort. A rating of *very poor* means that restrictions for the element of wildlife habitat or kind of wildlife are very severe, and that unsatisfactory results can be expected. Wildlife habitat is impractical or even impossible to create, improve, or maintain on soils having such a rating.

The elements of wildlife habitat are briefly described in the following paragraphs.

Grain and seed crops are seed-producing annuals used by wildlife. Examples are corn, wheat, oats, barley, and sunflowers. The major soil properties that affect the growth of grain and seed crops are depth of the root zone, texture of the surface layer, available water capacity, wetness, slope, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Grasses and legumes are domestic perennial grasses and herbaceous legumes that are planted for wildlife food and cover. Examples are wheatgrass, bluegrass, switchgrass, bromegrass, clover, alfalfa, trefoil, and crownvetch. Major soil properties that affect the growth of grasses and legumes are depth of the root zone, texture of the surface layer, available water capacity, wetness, surface stoniness, flood hazard, and slope. Soil temperature and soil moisture are also considerations.

Wild herbaceous plants are native or naturally established herbaceous grasses and forbs, including weeds, that provide food and cover for wildlife. Examples are bluestem, goldenrod, beggarweed, pokeweed, partridgepea, wheatgrass, and grama. Major soil properties that affect the growth of these plants are depth of the root zone, texture of the surface

[5] By ERLING B. PODOLL, biologist, Soil Conservation Service, Bismarck, N. Dak.

layer, available water capacity, wetness, surface stoniness, and flood hazard. Soil temperature and soil moisture are also considerations.

Shrubs are bushy woody plants that produce fruits, buds, twigs, bark, or foliage used by wildlife or that provide cover and shade for some species of wildlife. Examples are chokecherry, juneberry, prairierose, and snowberry.

Major soil properties that affect the growth of shrubs are depth of the root zone, available water capacity, salinity, and moisture.

Wetland plants are annual and perennial wild herbaceous plants that grow on moist or wet sites, exclusive of submerged or floating aquatics. They produce food or cover for wildlife that use wetland as habitat. Examples of wetland plants are smartweed, rushes, sedges, reeds, saltgrass, cordgrass, and cattail. Major soil properties affecting wetland plants are texture of the surface layer, wetness, reaction, salinity, slope, and surface stoniness.

Shallow water areas are bodies of surface water that have an average depth of less than 5 feet and are useful to wildlife. They can be naturally wet areas, or they can be created by dams or levees or by water-control devices in marshes or streams. Examples are muskrat marshes, waterfowl feeding areas, wildlife watering developments, beaver ponds, and other wildlife ponds. Major soil properties affecting shallow water areas are depth to bedrock, wetness, surface stoniness, slope, and permeability. The availability of a dependable water supply is important if water areas are to be developed.

The kinds of wildlife habitat are briefly described in the following paragraphs.

Openland habitat consists of croplands, pastures, meadows, and areas that are overgrown with grasses, herbs, shrubs, and vines. These areas produce grain and seed crops, grasses and legumes, and wild herbaceous plants. The kinds of wildlife attracted to these areas include pheasant, meadowlark, field sparrow, killdeer, cottontail rabbit, and red fox.

Wetland habitat consists of water-tolerant plants in open, marshy, or swampy shallow water areas. Examples of wildlife attracted to this habitat are ducks, geese, herons, shore birds, rails, kingfishers, muskrat, mink, and beaver.

Rangeland habitat consists of wild herbaceous plants and shrubs on range. Examples of wildlife attracted to this habitat are antelope, white-tailed deer, mule deer, sharp-tailed grouse, horned lark, meadowlark, and lark bunting.

Recreation

McLean County has a number of developed recreation areas. Good facilities are available for play areas, picnic areas, and camp areas. Additional development of paths and trails is needed. The need will increase as tourist use of the area increases.

Public land is also available for many recreation activities in the county. It is largely owned by the Department of the Army and the Department of Interior.

The soils of the survey area are rated in table 6, according to limitations that affect their suitability for camp areas, picnic areas, playgrounds, and paths and trails. The ratings are based on such restrictive soil features as flooding, wetness, slope, and texture of the surface layer. Not considered in these ratings, but important in evaluating a site, are location and accessibility of the area, size and shape of the area and its scenic quality, the ability of the soil to support vegetation, access to water, potential water impoundment sites available, and either access to public sewerlines or capacity of the soil to absorb septic tank effluent. Soils subject to flooding are limited, in varying degree, for recreational use by the duration of flooding and the season when it occurs. Onsite assessment of height, duration, and frequency of flooding is essential in planning recreational facilities.

In table 6 the limitations of soils are rated as slight, moderate, or severe. *Slight* means that the soil properties are generally favorable and that the limitations are minor and easily overcome. *Moderate* means that the limitations can be overcome or alleviated by planning, design, or special maintenance. *Severe* means that soil properties are unfavorable and that limitations can be offset only by costly soil reclamation, special design, intensive maintenance, limited use, or by a combination of these measures.

The information in table 6 can be supplemented by additional information in other parts of this survey. Especially helpful are interpretations for septic tank absorption fields, given in table 8, and interpretations for dwellings without basements and for local roads and streets, given in table 7.

Camp areas require such site preparation as shaping and leveling tent and parking areas, stabilizing roads and intensively used areas, and installing sanitary facilities and utility lines. Camp areas are subject to heavy foot traffic and some vehicular traffic. The best soils for this use have mild slopes and are not wet or subject to flooding during the period of use. The surface has few or no stones or boulders, absorbs rainfall readily but remains firm, and is not dusty when dry. Strong slopes and stones or boulders can greatly increase the cost of constructing camping sites.

Picnic areas are subject to heavy foot traffic. Most vehicular traffic is confined to access roads and parking areas. The best soils for use as picnic areas are firm when wet, are not dusty when dry, are not subject to flooding during the period of use, and do not have slopes or stones or boulders that will increase the cost of shaping sites or of building access roads and parking areas.

Playgrounds require soils that can withstand intensive foot traffic. The best soils are almost level and are not wet or subject to flooding during the season of use. The surface is free of stones or boulders, is firm after rains, and is not dusty when dry. If shaping is required to obtain a uniform grade, the depth of the soil over rock should be sufficient to allow necessary grading.

The design and layout of *paths and trails* for walking, horseback riding, and bicycling should require little or no cutting and filling. The best soils for this use are those that are not wet, are firm after rains, are not dusty when dry, and are not subject to flooding more than once during the period of use. They should

TABLE 5.—*Wildlife*

[See text for definitions of "good," "fair," "poor," and "very

Soil and map symbol	Potential for habitat elements				
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants
Aquents:					
Ac	Very poor	Very poor	Fair		
Aquolls:					
Af	Very poor	Very poor	Very poor		
Arnegard:					
ArA	Good	Good	Good		
ArB, ArC	Good	Good	Good		
Banks:					
Ba	Poor	Fair	Fair		
Bk	Fair	Good	Fair		
Bowbells:					
BoA	Good	Good	Good		
[1] BsB:					
Bowbells part	Good	Good	Good		
Williams part	Good	Good	Good		
Bowdle:					
BwA	Fair	Fair	Good		
[1] ByB:					
Bowdle part	Fair	Fair	Good		
Stady part	Fair	Fair	Good		
[1] ByC:					
Bowdle part	Poor	Fair	Good		
Stady part	Poor	Fair	Good		
Cabba:					
[1] CaE	Very poor	Very poor	Fair		
[1] CbF:					
Cabba part	Very poor	Very poor	Fair		
Shale outcrop part.					
Cohagen:					
[1] ChD:					
Cohagen part	Poor	Fair	Fair		
Vebar part	Poor	Fair	Good		
[1] ChE:					
Cohagen part	Very poor	Very poor	Fair		
Vebar part	Very poor	Very poor	Fair		
Colvin:					
Co	Poor	Fair	Fair		
Dimmick:					
Dm	Very poor	Poor	Poor		
Divide:					
Dv	Fair	Fair	Good		
Falkirk:					
FaA	Good	Good	Good		
FaB	Fair	Good	Good		

habitat potentials

poor." Absence of an entry indicates that the soil was not rated]

Potential for habitat elements—Continued			Potential as habitat for—			
Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Fair	Fair	Good	Very poor		Fair	Fair.
Very poor	Good	Good	Very poor		Good	Very poor.
Good	Poor	Very poor	Good		Very poor	Good.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Very poor	Very poor	Poor		Very poor	Fair.
Good	Very poor	Very poor	Fair		Very poor	Fair.
Good	Poor	Poor	Good		Poor	Good.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
	Very poor	Very poor	Fair		Very poor	Good.
	Very poor	Very poor	Fair		Very poor	Good.
Fair	Poor	Very poor	Fair		Very poor	Fair.
Fair	Poor	Very poor	Fair		Very poor	Fair.
Fair	Poor	Very poor	Fair		Very poor	Fair.
Fair	Very poor	Very poor	Poor		Very poor	Fair.
Fair	Very poor	Very poor	Poor		Very poor	Fair.
Poor	Very poor	Very poor	Fair		Very poor	Poor.
Very poor	Very poor	Very poor	Fair		Very poor	Good.
Poor	Very poor	Very poor	Poor		Very poor	Poor.
Very poor	Very poor	Very poor	Poor		Very poor	Poor.
Fair	Good	Good	Poor		Good	Fair.
Poor	Poor	Good	Very poor		Fair	Poor.
Fair	Fair	Very poor	Fair		Poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Good.
Fair	Poor	Very poor	Good		Very poor	Fair.

TABLE 5.—*Wildlife habitat*

Soil and map symbol	Potential for habitat elements				
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants
[1] FbA:					
Falkirk part	Good	Good	Good		
Max part	Good	Good	Good		
[1] FbB:					
Falkirk part	Good	Good	Good		
Max part	Good	Good	Good		
[1] FbC:					
Falkirk part	Fair	Good	Good		
Max part	Fair	Good	Good		
Farnuf:					
FfA, FfB	Fair	Good	Good		
Flasher:					
FlD	Poor	Fair	Fair		
FlE	Very poor	Very poor	Fair		
Flaxton:					
FnA, FnB, FnC	Fair	Good	Good		
Fossum:					
Fs	Poor	Fair	Fair		
Grail:					
GaA, GaB	Good	Good	Fair		
Grano:					
Gn	Poor	Poor	Poor		
Grassna:					
GoA	Good	Good	Fair		
Hamerly:					
HaA	Good	Good	Good		
Harriet:					
[1] Hk:					
Harriet part	Poor	Poor	Fair		
Saline land part.					
Havrelon:					
Hn, Ho	Good	Good	Fair		
Heil:					
Hs	Poor	Poor	Fair		
Krem:					
KrB	Fair	Good	Good		
Lallie:					
La	Poor	Fair	Good		
Lihen:					
LeB, LeC	Fair	Fair	Good		
[1] LgE:					
Lihen part	Poor	Fair	Good		
Zahl part	Poor	Fair	Good		
Linton:					
[1] LmB:					
Linton part	Good	Good	Fair		

potentials—Continued

Potential for habitat elements—Continued			Potential as habitat for—			
Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Fair	Poor	Very poor	Good		Very poor	Good.
Poor	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Good.
Poor	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Poor	Very poor	Very poor	Fair		Very poor	Fair.
Good			Good			Good.
Poor	Very poor	Very poor	Fair		Very poor	Poor.
Poor	Very poor	Very poor	Poor		Very poor	Poor.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Good	Good	Fair		Good	Fair.
Good	Poor	Very poor	Good		Very poor	Fair.
Poor	Good	Good	Poor		Good	Poor.
Good	Poor	Very poor	Good		Very poor	Fair.
Fair	Fair	Fair	Good		Fair	Fair.
Very poor	Good	Good	Poor		Good	Poor.
Good	Poor	Very poor	Good		Very poor	Fair.
Very poor	Good	Good	Poor		Good	Poor.
Fair	Poor	Very poor	Good		Very poor	Fair.
Good	Good	Good	Fair		Good	Good.
Good			Fair			Good.
Good			Fair			Good.
Fair	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.

TABLE 5.—*Wildlife habitat*

Soil and map symbol	Potential for habitat elements				
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants
Mandan part	Good	Good	Fair		
[1]LmC:					
Linton part	Fair	Good	Fair		
Mandan part	Fair	Good	Fair		
[1]LmD:					
Linton part	Fair	Good	Fair		
Mandan part	Fair	Good	Fair		
[1]LmE:					
Linton part	Poor	Fair	Fair		
Mandan part	Poor	Fair	Fair		
Lohler:					
Lw	Good	Good	Fair		
Ly	Good	Good	Poor		
Makoti:					
Ma	Good	Good	Fair		
Mandan:					
MdA, MdB	Good	Good	Fair		
MdC	Fair	Good	Fair		
Marysland:					
Mf	Poor	Fair	Fair		
Max:					
MgB	Good	Good	Good		
[1]MhC:					
Max part	Fair	Good	Good		
Bowbells part	Fair	Good	Good		
Zahl part	Fair	Good	Good		
[1]MlC:					
Max part	Fair	Good	Good		
Zahl part	Fair	Good	Good		
[1]MlD:					
Max part	Fair	Good	Good		
Zahl part	Poor	Fair	Good		
Morton:					
MoC	Fair	Good	Fair		
Niobell:					
[1]NbA:					
Niobell part	Fair	Fair	Good		
Williams part	Good	Good	Good		
[1]NbB:					
Niobell part	Fair	Fair	Good		
Williams part	Good	Good	Good		
Noonan:					
[1]NmB:					
Noonan part	Poor	Poor	Very poor		

potentials—Continued

Potential for habitat elements—Continued			Potential as habitat for—			
Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Very poor	Very poor	Fair		Very poor	Fair.
Good	Poor	Fair	Good		Poor	Fair.
Good	Poor	Fair	Fair		Poor	Fair.
Fair	Very poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Good	Good	Fair		Good	Fair.
Poor	Poor	Very poor	Good		Very poor	Fair.
Poor	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Poor	Very poor	Fair		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Poor	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Poor	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Poor	Very poor	Fair		Very poor	Fair.
Poor	Poor	Poor	Fair		Poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Poor	Poor	Very poor	Fair		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Very poor	Poor	Very poor	Poor		Very poor	Very poor.

TABLE 5.—*Wildlife habitat*

Soil and map symbol	Potential for habitat elements				
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants
Miranda part	Very poor	Very poor	Very poor		
[1] NmD: Noonan part	Poor	Poor	Very poor		
Miranda part	Very poor	Very poor	Very poor		
Nutley: NtA, NtB	Poor	Fair	Poor		
Orthents: Or	Very poor	Very poor	Very poor		
Parnell: Pa	Poor	Poor	Poor		
Pe	Very poor	Very poor	Poor		
Parshall: PhA, PhB, PhC	Fair	Good	Good		
PhD	Poor	Good	Good		
PoA, PoB	Good	Good	Good		
Regent: RgC	Fair	Good	Good		
Rhoades: [1] RhB	Poor	Poor	Poor		
Riverwash: Rm.					
Roseglen: Ro	Good	Good	Fair		
[1] RpB: Roseglen part	Good	Good	Fair		
Tansem part	Good	Good	Good		
[1] RpC: Roseglen part	Fair	Good	Fair		
Tansem part	Good	Good	Good		
Ruso: RsA, RzA	Fair	Good	Good		
[1] RtB: Ruso part	Fair	Good	Good		
Manning part	Fair	Good	Good		
[1] RtC: Ruso part	Fair	Good	Good		
Manning part	Fair	Good	Good		
[1] RxB: Ruso part	Fair	Good	Good		
Manning part	Fair	Good	Good		
[1] RyC: Ruso part	Fair	Good	Good		
Wabek part	Poor	Poor	Poor		

potentials—Continued

Potential for habitat elements—Continued			Potential as habitat for—			
Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Very poor	Very poor	Poor	Very poor		Very poor	Very poor.
Very poor	Poor	Very poor	Poor		Very poor	Very poor.
Very poor	Very poor	Poor	Very poor		Very poor	Very poor.
	Very poor	Very poor	Poor		Very poor	Poor.
Very poor	Very poor	Very poor	Very poor		Very poor	Very poor.
	Good	Good	Poor		Good	
	Good	Good	Very poor		Good	
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Poor	Poor	Very poor	Fair		Very poor	Fair.
Very poor	Poor	Poor	Poor		Poor	Very poor.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Fair		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Poor	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Poor	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Poor	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Poor	Very poor	Very poor	Poor		Very poor	Poor.

TABLE 5.—*Wildlife habitat*

Soil and map symbol	Potential for habitat elements				
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants
Seroco: SeD	Very poor	Very poor	Fair		
Sinai: Sn	Fair	Fair	Fair		
Straw: St	Good	Good	Good		
[1] Sx	Poor	Fair	Good		
Telfer: [1] TlC: Telfer part	Poor	Fair	Good		
Lihen part	Fair	Fair	Good		
Tonka: [1] Tp: Tonka part	Poor	Poor	Fair		
Parnell part	Poor	Poor	Poor		
Trembles: Tr	Fair	Good	Good		
Vebar: [1] VwC: Vebar part	Fair	Good	Good		
Williams part	Fair	Good	Good		
Wabek: [1] WaB: Wabek part	Poor	Poor	Poor		
Max part	Good	Good	Good		
Zahl part	Fair	Good	Good		
[1] WaD: Wabek part	Poor	Poor	Poor		
Max part	Fair	Good	Good		
Zahl part	Poor	Fair	Good		
[1] WbB, [1] WbD	Poor	Poor	Poor		
Williams: WlB, WmA, WmB, WrB	Good	Good	Good		
[1] WoA: Williams part	Good	Good	Good		
Bowbells part	Good	Good	Good		
[1] WoB: Williams part	Good	Good	Good		
Bowbells part	Good	Good	Good		
[1] WoC: Williams part	Fair	Good	Good		
Bowbells part	Fair	Good	Good		
[1] WpB: Williams part	Good	Good	Good		

potentials—Continued

Potential for habitat elements—Continued			Potential as habitat for—			
Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Good	Very poor	Very poor	Poor		Very poor	Fair.
	Poor	Poor	Fair		Poor	Fair.
Good	Poor	Very poor	Good		Very poor	Good.
Fair	Poor	Very poor	Fair		Very poor	Fair.
Fair	Very poor	Very poor	Fair		Very poor	Fair.
Good	Poor	Very poor	Fair		Very poor	Good.
Poor	Good	Good	Poor		Good	Poor.
Poor	Good	Good	Poor		Good	Poor.
Good			Good			Good.
Very poor	Poor	Very poor	Good		Very poor	Good.
Fair	Poor	Very poor	Good		Very poor	Fair.
Poor	Very poor	Very poor	Poor		Very poor	Poor.
Poor	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Poor	Very poor	Very poor	Poor		Very poor	Poor.
Poor	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Very poor	Very poor	Fair		Very poor	Fair.
Poor	Very poor	Very poor	Poor		Very poor	Poor.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Good	Poor	Poor	Good		Poor	Good.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.

TABLE 5.—*Wildlife habitat*

Soil and map symbol	Potential for habitat elements				
	Grain and seed crops	Grasses and legumes	Wild herbaceous plants	Hardwood trees	Coniferous plants
Bowbells part	Good	Good	Good		
Zahl part	Fair	Good	Good		
Wilton:					
WsA	Good	Good	Fair		
[1] WtB:					
Wilton part	Good	Good	Fair		
Temvik part	Good	Good	Fair		
[1] WwC:					
Wilton part	Fair	Good	Fair		
Williams part	Fair	Good	Good		
Zahl:					
[1] ZcE:					
Zahl part	Poor	Fair	Good		
Cabba part	Very poor	Very poor	Fair		
[1] ZmE:					
Zahl part	Poor	Fair	Good		
Max part	Poor	Good	Good		
[1] ZpE:					
Zahl part	Poor	Fair	Good		
Max part	Poor	Fair	Good		
Parnell part	Poor	Poor	Poor		
[1] ZwC:					
Zahl part	Fair	Good	Good		
Williams part	Fair	Good	Good		

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and

have moderate slopes and have few or no stones or boulders on the surface.

Engineering[6]

This section provides information about the use of soils for building sites, sanitary facilities, construction materials, and water management. Among those who can benefit from this section are engineers, landowners, community officials and planners, town and city managers, land developers, builders, contractors, and farmers and ranchers.

The ratings in tables in this section are based on test data and estimated data in the "Soil Properties" section. The ratings were determined jointly by soil scientists and engineers of the Soil Conservation Service using known relationships between the soil properties and the behavior of soils in various engineering uses.

[6] DENNIS F. MEYER, area engineer, Soil Conservation Service, helped prepare this section.

Among the soil properties and site conditions identified by the soil survey and used in determining the ratings in this section are grain-size distribution, liquid limit, plasticity index, soil reaction, depth to and hardness of bedrock within 5 or 6 feet of the surface, soil wetness characteristics, depth to a seasonal water table, slope, likelihood of flooding, natural soil structure or aggregation, in-place soil density, and geologic origin of the soil material. Where pertinent, data about kinds of clay minerals, mineralogy of the sand and silt fractions, and the kind of absorbed cations were also considered.

Based on the information assembled about soil properties, ranges of values may be estimated for erodibility, permeability, risk of corrosion, shrink-swell potential, available water capacity, shear strength, compressibility, slope stability, and other factors of expected soil behavior in engineering uses. As appropriate, these values can be applied to each major horizon of each soil or to the entire profile.

These factors of soil behavior affect construction

potentials—Continued

Potential for habitat elements—Continued			Potential as habitat for—			
Shrubs	Wetland plants	Shallow water areas	Openland wildlife	Woodland wildlife	Wetland wildlife	Rangeland wildlife
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Fair		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Very poor	Very poor	Fair		Very poor	Fair.
Fair						Fair.
Fair	Very poor	Very poor	Fair		Very poor	Fair.
Poor	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Very poor	Very poor	Fair		Very poor	Fair.
Fair	Very poor	Very poor	Fair		Very poor	Fair.
Poor	Good	Good	Poor		Good	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.
Fair	Poor	Very poor	Good		Very poor	Fair.

behavior characteristics of the mapping unit.

and maintenance of roads, airport runways, pipelines, foundations for small buildings, ponds and small dams, irrigation projects, drainage systems, sewage and refuse disposal systems, and other engineering works. The ranges of values can be used to—(1) select potential residential, commercial, industrial, and recreational areas; (2) make preliminary estimates pertinent to construction in a particular area; (3) evaluate alternate routes for roads, streets, highways, pipelines, and underground cables; (4) evaluate alternate sites for location of sanitary landfills, onsite sewage disposal systems, and other waste disposal facilities; (5) plan detailed onsite investigations of soils and geology; (6) find sources of gravel, sand, clay, and topsoil; (7) plan farm drainage systems, irrigation systems, ponds, terraces, and other structures for soil and water conservation; (8) relate performance of structures already built to the properties of the kinds of soil on which they are built so that performance of similar structures on the same or a similar soil in other locations can be predicted; and (9) predict the trafficability of soils for cross-country movement of vehicles and construction equipment.

Data presented in this section are useful for land-use planning and for choosing alternative practices or general designs that will overcome unfavorable soil properties and minimize soil-related failures. Limitations to the use of these data, however, should be well understood. First, the data are generally not presented for soil material below a depth of 5 or 6 feet. Also, because of the scale of the detailed map in this soil survey, small areas of soils that differ from the dominant soil may be included in mapping. Thus, these data do not eliminate the need for onsite investigations and testing.

The information is presented mainly in tables. Table 7 shows, for each kind of soil, ratings of the degree and kind of limitations for building site development; table 8, for sanitary facilities; and table 9, for water management. Table 10 shows the suitability of each kind of soil as a source of construction material.

TABLE 6.—*Recreation*

[Terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe"]

Soil and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Aquents:				
Ac	Severe: floods	Severe: floods	Severe: floods	Severe: floods.
Aquolls:				
Af	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness.
Arnegard:				
ArA, ArB	Slight	Slight	Moderate: slope	Slight.
ArC	Slight	Slight	Severe: slope	Slight.
Banks:				
[1] Ba	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy.
[1] Bk	Slight	Slight	Slight	Slight.
Bowbells:				
BoA	Slight	Slight	Moderate: slope	Slight.
[2] BsB:				
Bowbells part	Slight	Slight	Moderate: slope	Slight.
Williams part	Slight	Slight	Moderate: slope	Slight.
Bowdle:				
BwA	Slight	Slight	Moderate: slope	Slight.
[2] ByB:				
Bowdle part	Slight	Slight	Moderate: slope	Slight.
Stady part	Slight	Slight	Moderate: slope	Slight.
[2] ByC:				
Bowdle part	Slight	Slight	Severe: slope	Slight.
Stady part	Slight	Slight	Severe: slope	Slight.
Cabba:				
[2] CaE	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
[2] CbF:				
Cabba part	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Shale outcrop part.				
Cohagen:				
[2] ChD:				
Cohagen part	Moderate: slope	Moderate: slope	Severe: depth to rock.	Slight.
Vebar part	Moderate: slope	Moderate: slope	Severe: slope	Slight.
[2] ChE:				
Cohagen part	Severe: slope	Severe: slope	Severe: depth to rock.	Severe: slope.
Vebar part	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Colvin:				
Co	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Dimmick:				
Dm	Severe: floods, wetness, too clayey.	Severe: floods, wetness, too clayey.	Severe: floods, wetness, too clayey.	Severe: wetness, too clayey.
Divide:				
Dv	Moderate: wetness	Moderate: wetness	Moderate: wetness	Moderate: wetness.

TABLE 6.—*Recreation*—Continued

Soil and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Falkirk:				
FaA	Slight	Slight	Moderate: slope	Slight.
FaB	Slight	Slight	Severe: slope	Slight.
[2] FbA:				
Falkirk part	Slight	Slight	Moderate: slope	Slight.
Max part	Slight	Slight	Moderate: slope	Slight.
[2] FbB:				
Falkirk part	Slight	Slight	Moderate: slope	Slight.
Max part	Slight	Slight	Moderate: slope	Slight.
[2] FbC:				
Falkirk part	Slight	Slight	Severe: slope	Slight.
Max part	Slight	Slight	Severe: slope	Slight.
Farnuf:				
FfA, FfB	Slight	Slight	Moderate: slope	Slight.
Flasher:				
FlD	Moderate: slope	Moderate: slope	Severe: slope	Slight.
FlE	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Flaxton:				
FnA, FnB	Slight	Slight	Moderate: slope	Slight.
FnC	Slight	Slight	Severe: slope	Slight.
Fossum:				
Fs	Severe: wetness, floods.	Severe: wetness	Severe: wetness	Severe: wetness.
Grail:				
GaA, GaB	Moderate: too clayey	Moderate: too clayey	Moderate: slope	Moderate: too clayey.
Grano:				
Gn	Severe: wetness, percs slowly.	Severe: wetness	Severe: wetness, percs slowly.	Severe: wetness.
Grassna:				
GoA	Slight	Slight	Moderate: slope	Slight.
Hamerly:				
HaA	Moderate: wetness, percs slowly.	Moderate: wetness	Moderate: wetness, percs slowly.	Moderate: wetness.
Harriet:				
[2] Hk:				
Harriet part	Severe: wetness, floods.	Severe: wetness	Severe: wetness, floods.	Severe: wetness.
Saline land part.				
Havrelon:				
[1] Hn	Slight	Slight	Slight	Slight.
[1] Ho	Moderate: too clayey	Moderate: too clayey	Moderate: too clayey	Moderate: too clayey.
Heil:				
Hs	Severe: wetness, percs slowly.	Severe: wetness	Severe: wetness, floods, percs slowly.	Severe: wetness.
Krem:				
KrB	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy	Moderate: too sandy.
Lallie:				
La	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.

TABLE 6.—*Recreation*—Continued

Soil and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Lihen:				
LeB	Moderate: too sandy	Moderate: too sandy	Moderate: slope, too sandy.	Moderate: too sandy.
LeC	Moderate: too sandy	Moderate: too sandy	Severe: slope	Moderate: too sandy.
[2] LgE:				
Lihen part	Severe: slope	Severe: slope	Severe: slope	Moderate: slope, too sandy.
Zahl part	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Linton:				
[2] LmB:				
Linton part	Slight	Slight	Moderate: slope	Slight.
Mandan part	Slight	Slight	Moderate: slope	Slight.
[2] LmC:				
Linton part	Slight	Slight	Severe: slope	Slight.
Mandan part	Slight	Slight	Severe: slope	Slight.
[2] LmD:				
Linton part	Moderate: slope	Moderate: slope	Severe: slope	Slight.
Mandan part	Moderate: slope	Moderate: slope	Severe: slope	Slight.
[2] LmE:				
Linton part	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Mandan part	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Lohler:				
[1] Lw	Moderate: too clayey	Moderate: too clayey	Moderate: too clayey	Moderate: too clayey.
[1] Ly	Severe: too clayey	Severe: too clayey	Severe: too clayey	Severe: too clayey.
Makoti:				
Ma	Moderate: too clayey	Moderate: too clayey	Moderate: too clayey	Moderate: too clayey.
Mandan:				
MdA	Slight	Slight	Slight	Slight.
MdB	Slight	Slight	Moderate: slope	Slight.
MdC	Slight	Slight	Severe: slope	Slight.
Marysland:				
Mf	Severe: wetness, floods.	Severe: wetness	Severe: wetness	Severe: wetness.
Max:				
MgB	Slight	Slight	Moderate: slope	Slight.
[2] MhC:				
Max part	Slight	Slight	Severe: slope	Slight.
Bowbells part	Slight	Slight	Severe: slope	Slight.
Zahl part	Slight	Slight	Severe: slope	Slight.
[2] MlC:				
Max part	Slight	Slight	Severe: slope	Slight.
Zahl part	Slight	Slight	Severe: slope	Slight.
[2] MlD:				
Max part	Moderate: slope	Moderate: slope	Severe: slope	Slight.
Zahl part	Moderate: slope	Moderate: slope	Severe: slope	Slight.
Morton:				
MoC	Slight	Slight	Severe: slope	Slight.

TABLE 6.—*Recreation*—Continued

Soil and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Niobell:				
[2] NbA:				
Niobell part	Moderate: percs slowly.	Moderate: wetness	Moderate: percs slowly.	Slight.
Williams part	Slight	Slight	Moderate: slope	Slight.
[2] NbB:				
Niobell part	Moderate: percs slowly.	Moderate: wetness	Moderate: percs slowly.	Slight.
Williams part	Slight	Slight	Moderate: slope	Slight.
Noonan:				
[2] NmB:				
Noonan part	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
Miranda part	Severe: percs slowly	Moderate: wetness	Severe: percs slowly.	Moderate: wetness.
[2] NmD:				
Noonan part	Moderate: percs slowly.	Moderate: percs slowly, slope.	Severe: slope	Slight.
Miranda part	Severe: percs slowly	Moderate: wetness	Severe: percs slowly.	Moderate: wetness.
Nutley:				
NtA, NtB	Severe: percs slowly, too clayey.	Severe: too clayey	Severe: percs slowly, too clayey.	Severe: too clayey.
Orthents:				
Or	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Parnell:				
Pa, Pe	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
Parshall:				
PhA, PhB, PoA, PoB	Slight	Slight	Moderate: slope	Slight.
PhC	Slight	Slight	Severe: slope	Slight.
PhD	Moderate: slope	Moderate: slope	Severe: slope	Slight.
Regent:				
RgC	Moderate: percs slowly, too clayey.	Moderate: too clayey	Severe: slope	Moderate: too clayey.
Rhoades:				
[2] RhB	Severe: percs slowly	Moderate: wetness	Severe: percs slowly.	Moderate: wetness.
Riverwash:				
Rm.				
Roseglen:				
Ro	Slight	Slight	Slight	Slight.
[2] RpB:				
Roseglen part	Slight	Slight	Moderate: slope	Slight.
Tansem part	Slight	Slight	Moderate: slope	Slight.
[2] RpC:				
Roseglen part	Slight	Slight	Severe: slope	Slight.
Tansem part	Slight	Slight	Severe: slope	Slight.
Ruso:				
RsA RzA	Slight	Slight	Moderate: slope	Slight.

TABLE 6.—*Recreation*—Continued

Soil and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
[2] RtB:				
Ruso part	Slight	Slight	Moderate: slope	Slight.
Manning part	Slight	Slight	Moderate: slope	Slight.
[2] RtC:				
Ruso part	Slight	Slight	Severe: slope	Slight.
Manning part	Slight	Slight	Severe: slope	Slight.
[2] RxB:				
Ruso part	Slight	Slight	Moderate: slope	Slight.
Manning part	Slight	Slight	Moderate: slope	Slight.
[2] RyC:				
Ruso part	Slight	Slight	Severe: slope	Slight.
Wabek part	Slight	Slight	Severe: slope	Slight.
Seroco: SeD	Severe: too sandy	Severe: too sandy	Severe: too sandy	Moderate: too sandy.
Sinai: Sn	Severe: too clayey, percs slowly.	Severe: too clayey	Severe: too clayey	Severe: too clayey.
Straw: St	Slight	Slight	Slight	Slight.
[2] Sx	Slight	Slight	Slight	Slight.
Telfer:				
[2] TlC:				
Telfer part	Moderate: too sandy	Moderate: too sandy	Severe: slope	Moderate: too sandy.
Lihen part	Moderate: too sandy	Moderate: too sandy	Severe: slope	Moderate: too sandy.
Tonka:				
[2] Tp:				
Tonka part	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Parnell part	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
Trembles: [1] Tr	Slight	Slight	Slight	Slight.
Vebar:				
[2] VwC:				
Vebar part	Slight	Slight	Severe: slope	Slight.
Williams part	Slight	Slight	Severe: slope	Slight.
Wabek:				
[2] WaB:				
Wabek part	Slight	Slight	Moderate: slope	Slight.
Max part	Slight	Slight	Moderate: slope	Slight.
Zahl part	Slight	Slight	Moderate: slope	Slight.
[2] WaD:				
Wabek part	Moderate: slope	Moderate: slope	Severe: slope	Slight.
Max part	Moderate: slope	Moderate: slope	Severe: slope	Slight.
Zahl part	Moderate: slope	Moderate: slope	Severe: slope	Slight.
[2] WbB	Slight	Slight	Moderate: slope	Slight.
[2] WbD	Moderate: slope	Moderate: slope	Severe: slope	Slight.

TABLE 6.—*Recreation*—Continued

Soil and map symbol	Camp areas	Picnic areas	Playgrounds	Paths and trails
Williams:				
WlB	Severe: large stones	Moderate: large stones.	Severe: large stones	Severe: large stones.
WmA, WmB	Moderate: too clayey	Moderate: too clayey	Moderate: slope	Moderate: too clayey.
[2] WoA:				
Williams part	Slight	Slight	Moderate: slope	Slight.
Bowbells part	Slight	Slight	Moderate: slope	Slight.
[2] WoB:				
Williams part	Slight	Slight	Moderate: slope	Slight.
Bowbells part	Slight	Slight	Moderate: slope	Slight.
[2] WoC:				
Williams part	Slight	Slight	Severe: slope	Slight.
Bowbells part	Slight	Slight	Severe: slope	Slight.
[2] WpB:				
Williams part	Slight	Slight	Moderate: slope	Slight.
Bowbells part	Slight	Slight	Moderate: slope	Slight.
Zahl part	Slight	Slight	Moderate: slope	Slight.
[2] WrB:				
Williams part	Severe: large stones	Moderate: large stones.	Severe: large stones	Severe: large stones.
Mine sink part.				
Wilton:				
WsA	Slight	Slight	Moderate: slope	Slight.
[2] WtB:				
Wilton part	Slight	Slight	Moderate: slope	Slight.
Temvik part	Moderate: percs slowly.	Slight	Moderate: percs slowly.	Slight.
[2] WwC:				
Wilton part	Slight	Slight	Severe: slope	Slight.
Williams part	Slight	Slight	Severe: slope	Slight.
Zahl:				
[2] ZcE:				
Zahl part	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Cabba part	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
[2] ZmE:				
Zahl part	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
Max part	Severe: slope	Severe: slope	Severe: slope	Moderate: slope.
[2] ZpE:				
Zahl part	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Max part	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Parnell part	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.	Severe: floods, wetness.
[2] ZwC:				
Zahl part	Slight	Slight	Severe: slope	Slight.
Williams part	Slight	Slight	Severe: slope	Slight.

[1] Protected from flooding by Garrison Dam.
[2] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

TABLE 7.—*Building site development*

[Terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," and "severe." Absence of an entry indicates that the soil was not rated]

Soil and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Roads and streets
Aquents:					
Ac	Severe: floods	Severe: floods	Severe: floods	Severe: floods	Severe: floods, frost action.
Aquolls:					
Af	Severe: wetness	Severe: wetness	Severe: wetness.	Severe: wetness.	Severe: wetness.
Arnegard:					
ArA, ArB, ArC	Slight	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.	Moderate: frost action.
Banks:					
[1] Ba, [1] Bk	Severe: too sandy.	Slight	Slight	Slight	Slight.
Bowbells:					
BoA	Moderate: wetness.	Moderate: low strength.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: shrink-swell, frost action, low strength.
[2] BsB:					
Bowbells part	Moderate: wetness.	Moderate: low strength.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: shrink-swell, frost action, low strength.
Williams part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
Bowdle:					
BwA	Severe: cutbanks cave.	Slight	Slight	Slight	Moderate: frost action, low strength.
[2] ByB:					
Bowdle part	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Moderate: frost action, low strength.
Stady part	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Moderate: frost action, low strength.
[2] ByC:					
Bowdle part	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Moderate: frost action, low strength.
Stady part	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Moderate: frost action, low strength.
Cabba:					
[2] CaE:	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
[2] CbF:					
Cabba part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Shale outcrop part.					
Cohagen:					
[2] ChD:					
Cohagen part	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.	Severe: slope	Moderate: depth to rock.
Vebar part	Moderate: depth to rock.	Moderate: slope	Moderate: depth to rock.	Severe: slope	Moderate: slope.

TABLE 7.—*Building site development*—Continued

Soil and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Roads and streets
ChE:					
Cohagen part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Vebar part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Colvin:					
Co	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods, frost action.
Dimmick:					
Dm	Severe: floods, wetness, too clayey.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.
Divide:					
Dv	Severe: wetness, cutbanks cave.	Moderate: wetness.	Severe: wetness.	Severe: wetness.	Moderate: wetness, frost action.
Falkirk:					
FaA, FaB	Slight	Moderate: low strength.	Moderate: shrink-swell, low strength.	Moderate: low strength.	Moderate: low strength, frost action.
[3] FbA:					
Falkirk part	Slight	Moderate: low strength.	Moderate: shrink-swell, low strength.	Moderate: low strength.	Moderate: low strength, frost action.
Max part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.
[3] FbB:					
Falkirk part	Slight	Moderate: low strength.	Moderate: shrink-swell, low strength.	Moderate: low strength.	Moderate: low strength, frost action.
Max part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.
[3] FbC:					
Falkirk part	Slight	Moderate: low strength.	Moderate: shrink-swell, low strength.	Moderate: low strength.	Moderate: low strength, frost action.
Max part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.
Farnuf:					
FfA, FfB	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, slope.	Moderate: frost action, shrink-swell, low strength.
Flasher:					
FlD	Moderate: depth to rock.	Moderate: depth to rock.	Moderate: depth to rock.	Severe: slope	Moderate: depth to rock.
FlE	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Flaxton:					
FnA, FnB, FnC	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.
Fossum:					
Fs	Severe: wetness, floods, cutbanks cave.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.

TABLE 7.—*Building site development*—Continued

Soil and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Roads and streets
Grail:					
GaA, GaB	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.
Grano:					
Gn	Severe: wetness, too clayey.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.	Severe: wetness, shrink-swell.
Grassna:					
GoA	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
Hamerly:					
HaA	Severe: wetness	Severe: frost action.	Severe: wetness.	Severe: wetness.	Severe: frost action.
Harriet:					
[2] Hk:					
Harriet part	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods, low strength.
Saline land part.					
Havrelon:					
[1] Hn, [1] Ho	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.
Heil:					
Hs	Severe: too clayey, wetness, floods.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.	Severe: wetness, floods, shrink-swell.
Krem:					
KrB	Moderate: cutbanks cave.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.
Lallie:					
La	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods, frost action.
Lihen:					
LeB	Severe: too sandy, cutbanks cave.	Slight	Slight	Slight	Slight.
LeC	Severe: too sandy, cutbanks cave.	Slight	Slight	Severe: slope	Slight.
[2] LqE:					
Lihen part	Severe: slope, too sandy, cutbanks cave.	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Zahl part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Linton:					
[2] LmB:					
Linton part	Slight	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.
Mandan part	Slight	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.
[2] LmC:					
Linton part	Slight	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.
Mandan part	Slight	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.

TABLE 7.—*Building site development*—Continued

Soil and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Roads and streets
[3] LmD:					
Linton part	Moderate: slope	Moderate: low strength.	Moderate: low strength.	Severe: slope	Moderate: low strength.
Mandan part	Moderate	Moderate: low strength.	Moderate: low strength.	Severe: slope	Moderate: low strength.
[3] LmE:					
Linton part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Moderate: low strength.
Mandan part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Moderate: low strength.
Lohler:					
[1] Lw, [1] Ly	Severe: too clayey.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.	Severe: low strength, shrink-swell.
Makoti:					
Ma	Moderate: wetness.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
Mandan:					
MdA, MdB, MdC	Slight	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.
Marysland:					
Mf	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods, frost action.
Max:					
MgB	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.
[3] MhC:					
Max part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.
Bowbells part	Moderate: wetness.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: shrink-swell, frost action, low strength.
Zahl part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
[3] MlC:					
Max part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.
Zahl part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
[3] MlD:					
Max part	Moderate: slope	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: slope	Moderate: shrink-swell, frost action.
Zahl part	Moderate: slope	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: slope	Moderate: frost action, shrink-swell.
Morton:					
MoC	Moderate: depth to rock.	Moderate: shrink-swell.	Moderate: depth to rock, shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.

TABLE 7.—*Building site development*—Continued

Soil and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Roads and streets
Niobell:					
[2] NbA:					
Niobell part	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.
Williams part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
[2] NbB:					
Niobell part	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.
Williams part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
Noonan:					
[2] NmB:					
Noonan part	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.
Miranda part	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
[2] NmD:					
Noonan part	Moderate: too clayey, wetness.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.
Miranda part	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: low strength.
Nutley:					
NtA, NtB	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: slope, shrink-swell, low strength.	Severe: low strength, shrink-swell.
Orthents:					
Or	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Parnell:					
Pa, Pe	Severe: floods, wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.
Parshall:					
PhA, PoA	Slight	Slight	Slight	Slight	Moderate: frost action.
PhB, PhC, PoB	Slight	Slight	Slight	Moderate: slope	Moderate: frost action.
PnD	Moderate: slope	Moderate: slope	Moderate: slope	Severe: slope	Moderate: frost action.
Regent:					
RgC	Severe: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Rhoades:					
[2] RhB:	Moderate: too clayey.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell.	Severe: shrink-swell, low strength.
Riverwash:					
Rm.					
Roseglen:					
Ro	Moderate: wetness.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.

TABLE 7.—*Building site development*—Continued

Soil and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Roads and streets
[a] RpB:					
Roseglen part	Moderate: wetness.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.
Tansem part	Slight	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.	Moderate: frost action, low strength.
[a] RpC:					
Roseglen part	Moderate: wetness.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.
Tansem part	Slight	Moderate: low strength.	Moderate: low strength.	Moderate: low strength.	Moderate: frost action, low strength.
Ruso:					
RsA, RzA	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
[a] RtB:					
Ruso part	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
Manning part	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
[a] RtC:					
Ruso part	Severe: cutbanks cave.	Slight	Slight	Severe: slope	Slight.
Manning part	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
[a] RxB:					
Ruso part	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
Manning part	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
[a] RyC:					
Ruso part	Severe: cutbanks cave.	Slight	Slight	Severe: slope	Slight.
Wabek part	Severe: cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
Seroco:					
SeD	Severe: cutbanks cave, too sandy.	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Sinai:					
Sn	Severe: too clayey.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.	Severe: shrink-swell, low strength.
Straw:					
St	Moderate: floods.	Severe: floods	Severe: floods	Severe: floods	Moderate: low strength, frost action, floods.
[a] Sx	Moderate: floods.	Severe: floods	Severe: floods	Severe: floods	Moderate: low strength, frost action, floods.
Telfer:					
[a] TlC:					
Telfer part	Severe: cutbanks cave, too sandy.	Slight	Slight	Moderate: slope	Slight.

TABLE 7.—*Building site development*—Continued

Soil and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Roads and streets
Lihen part	Severe: too sandy, cutbanks cave.	Slight	Slight	Moderate: slope	Slight.
Tonka:					
[2] Tp:					
Tonka part	Severe: wetness	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.	Severe: wetness, floods.
Parnell part	Severe: floods, wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.
Trembles:					
[1] Tr	Slight	Slight	Slight	Slight	Moderate: frost action.
Vebar:					
[2] VwC:					
Vebar part	Moderate: depth to rock.	Slight	Moderate: depth to rock.	Moderate: slope	Moderate: frost action.
Williams part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
Wabek:					
[2] WaB:					
Wabek part	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
Max part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell, frost action.
Zahl part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
[2] WaD:					
Wabek part	Severe: cutbanks cave.	Moderate: slope	Moderate: slope	Severe: slope	Moderate: slope.
Max part	Moderate: slope	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: slope	Moderate: shrink-swell, frost action.
Zahl part	Moderate: slope	Moderate: shrink-swell.	Moderate: shrink-swell.	Severe: slope	Moderate: frost action, shrink-swell.
[2] WbB	Severe: cutbanks cave.	Slight	Slight	Slight	Slight.
[2] WbD	Severe: cutbanks cave.	Moderate: slope	Moderate: slope	Severe: slope	Moderate: slope.
Williams:					
WlB	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
WmA, WmB	Moderate: too clayey.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
[2] WoA:					
Williams part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.

TABLE 7.—*Building site development*—Continued

Soil and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Roads and streets
Bowbells part	Moderate: wetness.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: shrink-swell, frost action, low strength.
[3] WoB: Williams part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
Bowbells part	Moderate: wetness.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: shrink-swell, frost action, low strength.
[3] WoC: Williams part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
Bowbells part	Moderate: wetness.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: shrink-swell, frost action, low strength.
[3] WpB: Williams part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
Bowbells part	Moderate: wetness.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: low strength, shrink-swell.	Moderate: shrink-swell, frost action, low strength.
Zahl part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
[3] WrB: Williams part	Severe: large stones.	Severe: large stones.	Severe: large stones.	Severe: large stones.	Moderate: frost action, shrink-swell, large stones.
Mine sink part.					
Wilton: WsA	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: frost action, low strength.
[3] WtB: Wilton part	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: frost action, low strength.
Temvik part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: low strength.
[3] WwC: Wilton part	Slight	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: shrink-swell, low strength.	Moderate: frost action, low strength.
Williams part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.

TABLE 7.—*Building site development*—Continued

Soil and map symbol	Shallow excavations	Dwellings without basements	Dwellings with basements	Small commercial buildings	Roads and streets
Zahl:					
[2] ZcE:					
Zahl part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Cabba part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
[2] ZmE:					
Zahl part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Max part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
[2] ZpE:					
Zahl part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Max part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Severe: slope.
Parnell part	Severe: floods, wetness.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.	Severe: floods, wetness, shrink-swell.
[2] ZwC:					
Zahl part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.
Williams part	Slight	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: shrink-swell.	Moderate: frost action, shrink-swell.

[1] Protected from flooding by Garrison Dam.
[2] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

The information in the tables along with the soil map, the soil descriptions, and other data provided in this survey can be used to make additional interpretations and to construct interpretive maps for specific uses of land.

Some of the terms used in this soil survey have different meanings in soil science. Many of these terms are defined in the Glossary.

Building site development

The degree and kind of soil limitations that affect shallow excavations, dwellings with and without basements, small commercial buildings, and local roads and streets are indicated in table 7. A *slight* limitation indicates that soil properties are favorable for the specified use; any limitation is minor and easily overcome. A *moderate* limitation indicates that soil properties and site features are unfavorable for the specified use, but the limitations can be overcome or minimized by special planning and design. A *severe* limitation indicates that one or more soil properties or site features are so unfavorable or difficult to overcome that a major increase in construction effort, special design, or intensive maintenance is required. For some soils rated severe, such costly measures may not be feasible.

Shallow excavations are used for pipelines, sewerlines, telephone and power transmission lines, basements, and open ditches. Such digging or trenching is influenced by soil wetness caused by a seasonal high water table, the texture and consistence of soils, the tendency of soils to cave in or slough, and the presence of very firm, dense soil layers, bedrock, or large stones. In addition, excavations are affected by slope of the soil and the probability of flooding. Ratings do not apply to soil horizons below a depth of 6 feet unless otherwise noted.

In the soil series descriptions, the consistence of each soil horizon is defined, and the presence of very firm or extremely firm horizons, usually difficult to excavate, is indicated.

Dwellings and small commercial buildings referred to in table 7 are built on undisturbed soil and have foundation loads of a dwelling no more than three stories high. Separate ratings are made for small commercial buildings without basements and for dwellings with and without basements. For such structures, soils should be sufficiently stable that cracking or subsidence from settling or shear failure of the foundation do not occur. These ratings were determined from estimates of the shear strength, compressibility, and shrink-swell potential of the soil. Soil texture, plasticity and in-place density, potential frost action, soil wetness, and depth to a seasonal high water table were also considered. Soil wetness and depth to a seasonal high water table indicate potential difficulty in providing adequate drainage for basements, lawns, and gardens. Depth to bedrock, slope, and the large stones in or on the soil are also important considerations in the choice of sites for these structures and were considered in determining the ratings. Susceptibility to flooding is a serious limitation.

TABLE 8.—*Sanitary facilities*

[Terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "slight," "moderate," "good," "fair," and other terms used to rate soils. Absence of an entry indicates that the soil was not rated]

Soil and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Aquents:					
Ac	Severe: floods, wetness.	Severe: wetness	Severe: floods, wetness.	Severe: floods, wetness.	Poor: wetness.
Aquolls:					
Af	Severe: wetness	Severe: wetness	Severe: wetness	Severe: wetness	Poor: wetness.
Arnegard:					
ArA, ArB	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
ArC	Moderate: percs slowly.	Severe: slope	Slight	Slight	Good.
Banks:					
[1] Ba, [1] Bk	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Fair: too sandy.
Bowbells:					
BoA	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
[2] BsB:					
Bowbells part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Williams part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Bowdle:					
BwA	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
[2] ByB:					
Bowdle part	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
Stady part	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
[2] ByC:					
Bowdle part	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
Stady part	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
Cabba:					
[2] CaE	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope	Poor: slope, thin layer, area reclaim.
[2] CbF:					
Cabba part	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope	Poor: slope, thin layer, area reclaim.
Shale outcrop part.					
Cohagen:					
[2] ChD:					
Cohagen part	Severe: depth to rock.	Severe: depth to rock, seepage.	Severe: seepage, depth to rock.	Severe: seepage	Poor: thin layer.
Vebar part	Severe: depth to rock.	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
[2] ChE:					
Cohagen part	Severe: depth to rock.	Severe: depth to rock, seepage.	Severe: seepage, depth to rock.	Severe: seepage	Poor: thin layer.
Vebar part	Severe: depth to rock.	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.

TABLE 8.—*Sanitary facilities*—Continued

Soil and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Colvin: Co	Severe: wetness, floods.	Severe: wetness	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Dimmick: Dm	Severe: floods, wetness, percs slowly.	Slight	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: wetness, too clayey.
Divide: Dv	Severe: wetness	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
Falkirk: FaA	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
FaB	Severe: percs slowly.	Severe: slope	Slight	Slight	Good.
[2] FbA: Falkirk part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Max part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
[2] FbB: Falkirk part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Max part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
[2] FbC: Falkirk part	Severe: percs slowly.	Severe: slope	Slight	Slight	Good.
Max part	Severe: percs slowly.	Severe: slope	Slight	Slight	Good.
Farnuf: FfA, FfB	Moderate: percs slowly.	Moderate: slope, seepage.	Slight	Slight	Good.
Flasher: FlD, FlE	Severe: depth to rock.	Severe: seepage, depth to rock.	Severe: seepage, depth to rock.	Severe: seepage	Poor: thin layer.
Flaxton: FnA, FnB	Severe: percs slowly.	Moderate: slope	Moderate: too clayey.	Slight	Good.
FnC	Severe: percs slowly.	Severe: slope	Moderate: too clayey.	Slight	Good.
Fossum: Fs	Severe: wetness, floods.	Severe: wetness, seepage.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Poor: wetness, too sandy.
Grail: GaA GaB	Severe: percs slowly.	Moderate: slope	Moderate: too clayey.	Slight	Fair: too clayey.
Grano: Gn	Severe: wetness, percs slowly.	Slight	Severe: wetness, too clayey.	Severe: wetness	Poor: wetness, too clayey.
Grassna: GoA	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.

TABLE 8.—*Sanitary facilities*—Continued

Soil and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Hamerly:					
HaA	Severe: percs slowly.	Moderate: wetness.	Severe: wetness	Moderate: wetness.	Good.
Harriet:					
[2] Hk:					
Harriet part	Severe: percs slowly, wetness.	Slight	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Saline land part.					
Havrelon:					
[1] Hn, [1] Ho	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
Heil:					
Hs	Severe: percs slowly, wetness, floods.	Slight	Severe: too clayey, wetness.	Severe: floods	Poor: too clayey, wetness.
Krem:					
KrB	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Lallie:					
La	Severe: wetness, floods.	Slight	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Lihen:					
LeB	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Fair: too sandy.
LeC	Slight	Severe: slope, seepage.	Severe: seepage	Severe: seepage	Fair: too sandy.
[2] LgE:					
Lihen part	Severe: slope	Severe: slope, seepage.	Severe: slope, seepage.	Severe: slope, seepage.	Poor: slope.
Zahl part	Severe: percs slowly.	Severe: slope	Moderate: slope	Severe: slope	Poor: slope.
Linton:					
[2] LmB:					
Linton part	Slight	Moderate: seepage.	Slight	Slight	Good.
Mandan part	Slight	Moderate: seepage.	Slight	Slight	Good.
[2] LmC:					
Linton part	Slight	Severe: slope	Slight	Slight	Good.
Mandan part	Slight	Severe: slope	Slight	Slight	Good.
[2] LmD:					
Linton part	Moderate: slope	Severe: slope	Slight	Moderate: slope	Fair: slope.
Mandan part	Moderate: slope	Severe: slope	Slight	Moderate: slope	Fair: slope.
[2] LmE:					
Linton part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Poor: slope.
Mandan part	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Poor: slope.
Lohler:					
[1] Lw, [1] Ly	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey.
Makoti:					
Ma	Severe: percs slowly.	Slight	Severe: wetness	Slight	Fair: too clayey.

TABLE 8.—*Sanitary facilities*—Continued

Soil and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Mandan: MdA, MdB	Slight	Moderate: seepage.	Slight	Slight	Good.
MdC	Slight	Severe: slope	Slight	Slight	Good.
Marysland: Mf	Severe: wetness, floods.	Severe: wetness, seepage.	Severe: wetness, seepage, floods.	Severe: wetness, seepage, floods.	Poor: wetness, thin layer.
Max: MgB	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
[2] MhC: Max part	Severe: percs slowly.	Severe: slope	Slight	Slight	Good.
Bowbells part	Severe: percs slowly.	Severe: slope	Slight	Slight	Good.
Zahl part	Severe: percs slowly.	Severe: slope	Slight	Slight	Good.
[2] MlC: Max part	Severe: percs slowly.	Severe: slope	Slight	Slight	Good.
Zahl part	Severe: percs slowly.	Severe: slope	Slight	Slight	Good.
[2] MlD: Max part	Severe: percs slowly.	Severe: slope	Slight	Moderate: slope	Fair: slope.
Zahl part	Severe: percs slowly.	Severe: slope	Slight	Moderate: slope	Fair: slope.
Morton: MoC	Severe: depth to rock.	Severe: depth to rock, slope.	Moderate: depth to rock.	Slight	Good.
Niobell: [2] NbA: Niobell part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Williams part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
[2] NbB: Niobell part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Williams part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Noonan: [2] NmB: Noonan part	Severe: percs slowly.	Moderate: slope	Moderate: too clayey.	Slight	Fair: too clayey.
Miranda part	Severe: percs slowly.	Slight	Moderate: too clayey.	Slight	Poor: thin layer.
[2] NmD: Noonan part	Severe: percs slowly.	Severe: slope	Moderate: too clayey.	Moderate: slope	Fair: too clayey.
Miranda part	Severe: percs slowly.	Severe: slope	Moderate: too clayey.	Moderate: slope	Poor: thin layer.

TABLE 8.—*Sanitary facilities*—Continued

Soil and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Nutley: NtA, NtB	Severe: percs slowly.	Severe: slope	Severe: too clayey.	Moderate: slope	Poor: too clayey.
Orthents: Or	Severe: slope	Severe: slope	Severe: slope	Severe: slope	Poor: slope.
Parnell: Pa, Pe	Severe: floods, wetness, percs slowly.	Severe: floods, wetness, excess humus.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: wetness.
Parshall: PhA, PhB, PhC, PoA, PoB	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Good.
PhD	Moderate: slope	Severe: seepage	Severe: seepage	Severe: seepage	Fair: slope.
Regent: RgC	Severe: percs slowly, depth to rock.	Moderate: slope	Severe: too clayey, depth to rock.	Slight	Poor: too clayey.
Rhoades: [a] RhB	Severe: percs slowly.	Moderate: slope	Severe: too clayey.	Slight	Poor: too clayey.
Riverwash: Rm.					
Roseglen: Ro	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
[a] RpB: Roseglen part	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
Tansem part	Moderate: percs slowly.	Moderate: seepage.	Slight	Slight	Good.
[a] RpC: Roseglen part	Moderate: percs slowly.	Severe: slope	Slight	Slight	Good.
Tansem part	Moderate: percs slowly.	Severe: slope	Slight	Slight	Good.
Ruso: RsA, RzA	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Poor: too sandy.
[a] RtB: Ruso part	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Poor: too sandy.
Manning part	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Poor: thin layer.
[a] RtC: Ruso part	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Poor: too sandy.
Manning part	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Poor: thin layer.
[a] RxB: Ruso part	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Poor: too sandy.
Manning part	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Poor: thin layer.
[a] RyC: Ruso part	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Poor: too sandy.
Wabek part	Slight	Severe: seepage	Severe: too sandy, seepage.	Severe: seepage	Poor: thin layer.
Seroco: SeD	Severe: slope	Severe: seepage	Severe: too sandy.	Severe: seepage	Poor: too sandy.

TABLE 8.—*Sanitary facilities*—Continued

Soil and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
Sinai:					
Sn	Severe: percs slowly.	Slight	Severe: too clayey.	Slight	Poor: too clayey.
Straw:					
St	Moderate: floods, percs slowly.	Moderate: seepage.	Moderate: floods.	Moderate: floods.	Good.
[2] Sx	Moderate: floods, percs slowly.	Moderate: seepage.	Moderate: floods.	Moderate: floods.	Good.
Telfer:					
[2] TlC:					
Telfer part	Slight	Severe: seepage	Severe: too sandy, seepage.	Severe: seepage	Poor: too sandy.
Lihen part	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Fair: too sandy.
Tonka:					
[2] Tp:					
Tonka part	Severe: wetness, floods.	Slight	Severe: wetness, floods.	Severe: wetness, floods.	Poor: wetness.
Parnell part	Severe: floods, wetness, percs slowly.	Severe: floods, wetness, excess humus.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: wetness.
Trembles:					
[2] Tr	Slight	Severe: seepage	Severe: seepage	Severe: seepage	Good.
Vebar:					
[2] VwC:					
Vebar part	Severe: depth to rock.	Severe: seepage	Severe: seepage	Severe: seepage	Fair: thin layer.
Williams part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Wabek:					
[2] WaB:					
Wabek part	Slight	Severe: seepage	Severe: too sandy, seepage.	Severe: seepage	Poor: thin layer.
Max part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Zahl part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
[2] WaD:					
Wabek part	Moderate: slope	Severe: seepage	Severe: too sandy, seepage.	Severe: seepage	Poor: thin layer.
Max part	Severe: percs slowly.	Severe: slope	Slight	Moderate: slope	Fair: slope.
Zahl part	Severe: percs slowly.	Severe: slope	Slight	Moderate: slope	Fair: slope.
[2] WbB	Slight	Severe: seepage	Severe: too sandy, seepage.	Severe: seepage	Poor: thin layer.
[2] WbD	Moderate: slope	Severe: seepage	Severe: too sandy, seepage.	Severe: seepage	Poor: thin layer.
Williams:					
WlB	Severe: percs slowly, large stones.	Moderate: slope, large stones.	Severe: large stones.	Slight	Poor: large stones.
WmA, WmB	Severe: percs slowly.	Moderate: slope	Moderate: too clayey.	Slight	Fair: too clayey.

TABLE 8.—*Sanitary facilities*—Continued

Soil and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
[2] WoA:					
Williams part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Bowbells part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
[2] WoB:					
Williams part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Bowbells part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
[2] WoC:					
Williams part	Severe: percs slowly.	Severe: slope	Slight	Slight	Good.
Bowbells part	Severe: percs slowly.	Severe: slope	Slight	Slight	Good.
[2] WpB:					
Williams part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Bowbells part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Zahl part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
[2] WrB:					
Williams part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Mine sink part.					
Wilton:					
WsA	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
[2] WtB:					
Wilton part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Temvik part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Wilton:					
[2] WwC:					
Wilton part	Severe: percs slowly.	Severe: slope	Slight	Slight	Good.
Williams part	Severe: percs slowly.	Severe: slope	Slight	Slight	Good.
Zahl:					
[2] ZcE:					
Zahl part	Severe: percs slowly.	Severe: slope	Severe: slope	Severe: slope	Poor: slope.
Cabba part	Severe: slope, depth to rock.	Severe: slope, depth to rock.	Severe: depth to rock, slope.	Severe: slope	Poor: slope, thin layer, area reclaim.
[2] ZmE:					
Zahl part	Severe: percs slowly.	Severe: slope	Slight	Severe: slope	Poor: slope.
Max part	Severe: percs slowly.	Severe: slope	Moderate: slope	Severe: slope	Poor: slope.

TABLE 8.—*Sanitary facilities*—Continued

Soil and map symbol	Septic tank absorption fields	Sewage lagoon areas	Trench sanitary landfill	Area sanitary landfill	Daily cover for landfill
[2] ZpE:					
Zahl part	Severe: percs slowly.	Severe: slope	Severe: slope	Severe: slope	Poor: slope.
Max part	Severe: percs slowly.	Severe: slope	Severe: slope	Severe: slope	Poor: slope.
Parnell part	Severe: floods, wetness, percs slowly.	Severe: floods, wetness, excess humus.	Severe: floods, wetness, too clayey.	Severe: floods, wetness.	Poor: wetness.
[2] ZwC:					
Zahl part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.
Williams part	Severe: percs slowly.	Moderate: slope	Slight	Slight	Good.

[1] Protected from flooding by Garrison Dam.
[2] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

Roads and streets referred to in table 7 have an all-weather surface that can carry light to medium traffic all year. They consist of a subgrade of the underlying soil material; a base of gravel, crushed rock fragments, or soil material stabilized with lime or cement; and a flexible or rigid surface, commonly asphalt or concrete. The roads are graded with soil material at hand, and most cuts and fills are less than 6 feet deep.

The load supporting capacity and the stability of the soil as well as the quantity and workability of fill material available are important in design and construction of roads and streets. The classifications of the soil and the soil texture, density, shrink-swell potential, and potential frost action are indicators of the traffic supporting capacity used in making the ratings. Soil wetness, flooding, slope, depth to hard rock or very compact layers, and content of large stones, all of which affect stability and ease of excavation, were also considered.

Sanitary facilities

Favorable soil properties and site features are needed for proper functioning of septic tank absorption fields, sewage lagoons, and sanitary landfills. The nature of the soil is important in selecting sites for these facilities and in identifying limiting soil properties and site features to be considered in design and installation. Also, those soil properties that deal with the ease of excavation or installation of these facilities will be of interest to contractors and local officials. Table 8 shows the degree and kind of limitations of each soil for these uses and for use of the soil as daily cover for landfills.

If the degree of soil limitation is indicated by the rating *slight,* soils are favorable for the specified use and limitations are minor and easily overcome; if *moderate,* soil properties or site features are unfavorable for the specified use, but limitations can be overcome by special planning and design; and if *severe,* soil properties or site features are so unfavorable or difficult to overcome that major soil reclamation, special designs, or intensive maintenance are required.

Septic tank absorption fields are subsurface systems of tile or perforated pipe that distribute effluent from a septic tank into the natural soil. Only the soil horizons between depths of 18 and 72 inches are evaluated for this use. The soil properties and site features considered are those that affect the absorption of the effluent and those that affect the construction of the system.

Properties and features that affect the absorption of the effluent are permeability, depth to seasonal high water table, depth to bedrock, and susceptibility to flooding. Stones, boulders, and a shallow depth to bedrock interfere with installation. Excessive slope may cause lateral seepage and surfacing of the effluent in downslope areas. Also, soil erosion and soil slippage are hazards where absorption fields are installed in sloping soils.

Some soils are underlain by loose sand and gravel or fractured bedrock at a depth less than 4 feet below the tile lines. In these soils the absorption field does not adequately filter the effluent, and as a result ground water supplies in the areas may be contaminated.

Percolation tests are performed to determine the absorptive capacity of the soil and its suitability for septic tank absorption fields. These tests should be performed during the season when the water table is highest and the soil is at minimum absorptive capacity.

In many of the soils that have moderate or severe limitations for septic tank absorption fields, it may be possible to install special systems that lower the seasonal water table; or it may be possible to increase the size of the absorption field so that satisfactory performance is achieved.

Sewage lagoons are shallow ponds constructed to hold sewage while aerobic bacteria decompose the solid and liquid wastes. Lagoons have a nearly level

TABLE 9.—*Water management*

[Terms that describe restrictive soil features are defined in the Glossary. Absence of an entry indicates that the soil was not evaluated]

Soil and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Aquents:						
Ac	Favorable	Low strength.	Poor outlets	Wetness	Not needed	Not needed.
Aquolls:						
Af	Favorable	Compressible, hard to pack, low strength.	Wetness, poor outlets.	Wetness	Not needed	Not needed.
Arnegard:						
ArA, ArB, ArC	Seepage	Piping, compressible, low strength.	Not needed	Favorable	Piping	Favorable.
Banks:						
[1] Ba, [1] Bk	Seepage	Hard to pack, piping.	Not needed	Complex slope, erodes easily.	Not needed	Not needed.
Bowbells:						
BoA	Favorable	Shrink-swell, low strength.	Not needed	Slow intake	Poor outlets	Favorable.
[2] BsB:						
Bowbells part	Favorable	Shrink-swell, low strength.	Not needed	Slow intake	Poor outlets	Favorable.
Williams part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, slow intake.	Complex slope, poor outlets.	Slope.
Bowdle:						
BwA	Seepage	Seepage	Not needed	Rooting depth.	Not needed	Not needed.
[2] ByB:						
Bowdle part	Seepage	Seepage	Not needed	Rooting depth.	Not needed	Not needed.
Stady part	Seepage	Seepage, piping.	Not needed	Rooting depth.	Rooting depth.	Not needed.
[2] ByC:						
Bowdle part	Seepage	Seepage	Not needed	Rooting depth.	Not needed	Not needed.
Stady part	Seepage	Seepage, piping.	Not needed	Rooting depth.	Rooting depth.	Not needed.
Cabba:						
[2] CaE	Slope, seepage, depth to rock.	Thin layer, piping, low strength.	Not needed	Complex slope, rooting depth.	Depth to rock, slope, rooting depth.	Rooting depth, slope, droughty.
[2] CbF:						
Cabba part	Slope, seepage, depth to rock.	Thin layer, piping, low strength.	Not needed	Complex slope, rooting depth.	Depth to rock, slope, rooting depth.	Rooting depth, slope, droughty.
Shale outcrop part.						
Cohagen:						
[2] ChD:						
Cohagen part	Seepage, slope.	Thin layer, seepage.	Not needed	Complex slope, droughty, rooting depth.	Depth to rock, slope, erodes easily.	Erodes easily, slope.
Vebar part	Seepage, depth to rock.	Piping	Not needed	Erodes easily, rooting depth.	Depth to rock.	Erodes easily, slope.

TABLE 9.—*Water management*—Continued

Soil and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
[3] ChE:						
Cohagen part	Seepage, slope.	Thin layer, seepage.	Not needed	Complex slope, droughty, rooting depth.	Depth to rock, slope, erodes easily.	Erodes easily, slope.
Vebar part	Seepage, depth to rock.	Piping	Not needed	Erodes easily, rooting depth.	Depth to rock.	Erodes easily, slope.
Colvin:						
Co	Favorable	Low strength, compressible.	Poor outlets, wetness, percs slowly.	Floods, wetness, percs slowly.	Not needed	Not needed.
Dimmick:						
Dm	Favorable	Compressible, hard to pack, low strength.	Wetness, floods, poor outlets.	Wetness, slow intake.	Percs slowly, wetness, poor outlets.	Not needed.
Divide:						
Dv	Seepage	Seepage	Wetness, cutbanks cave.	Wetness, seepage.	Not needed	Not needed.
Falkirk:						
FaA, FaB	Favorable	Compressible, piping.	Not needed	Percs slowly	Favorable	Favorable.
[3] FbA:						
Falkirk part	Favorable	Compressible, piping.	Not needed	Percs slowly	Favorable	Favorable.
Max part	Slope	Shrink-swell, low strength.	Not needed	Complex slope.	Complex slope, poor outlets.	Slope, erodes easily.
[3] FbB:						
Falkirk part	Favorable	Compressible, piping.	Not needed	Percs slowly	Favorable	Favorable.
Max part	Slope	Shrink-swell, low strength.	Not needed	Complex slope.	Complex slope, poor outlets.	Slope, erodes easily.
[3] FbC:						
Falkirk part	Favorable	Compressible, piping.	Not needed	Percs slowly	Favorable	Favorable.
Max part	Slope	Shrink-swell, low strength.	Not needed	Complex slope.	Complex slope, poor outlets.	Slope, erodes easily.
Farnuf:						
FfA FfB	Slope, seepage.	Piping, low strength.	Slope	Slope	Slope, erodes easily.	Slope, erodes easily.
Flasher:						
FlD, FE	Depth to rock, slope.	Thin layer, seepage.	Not needed	Slope, rooting depth.	Slope, depth to rock, erodes easily.	Erodes easily, slope.
Flaxton:						
FnA, FnB, FnC	Seepage	Compressible, piping low strength.	Not needed	Complex slope, erodes easily.	Complex slope, piping.	Erodes easily.
Fossum:						
Fs	Seepage	Seepage, piping.	Wetness, cutbanks cave, floods.	Wetness, floods, fast intake.	Not needed	Not needed.
Grail:						
GaA, GaB	Favorable	Compressible, low strength, piping.	Not needed	Slow intake	Piping	Favorable.

TABLE 9.—*Water management*—Continued

Soil and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Grano:						
Gn	Favorable	Compressible, hard to pack.	Wetness, percs slowly.	Wetness, percs slowly.	Wetness, percs slowly.	Not needed.
Grassna:						
GoA	Seepage	Compressible, low strength, piping.	Not needed	Favorable	Piping	Favorable.
Hamerly:						
HaA	Favorable	Compressible, piping, low strength.	Percs slowly	Slow intake, wetness.	Percs slowly, poor outlets, piping.	Percs slowly.
Harriet:						
[2] Hk:						
Harriet part	Favorable	Compressible, low strength.	Wetness, floods, percs slowly.	Slow intake, excess alkali, excess salt.	Percs slowly, rooting depth.	Not needed.
Saline land part						
Havrelon:						
[1] Hn, [1] Ho	Seepage	Compressible, piping, low strength.	Not needed	Favorable	Piping	Not needed.
Heil:						
Hs	Favorable	Compressible, hard to pack, low strength.	Wetness, floods, percs slowly.	Slow intake, excess alkali.	Not needed	Not needed.
Krem:						
KrB	Slope	Erodes easily, shrink-swell.	Not needed	Complex slope, erodes easily.	Complex slope, erodes easily.	Erodes easily, slope.
Lallie:						
La	Favorable	Compressible, hard to pack.	Wetness, poor outlets.	Wetness, slow intake.	Wetness, percs slowly.	Not needed.
Lihen:						
LeB, LeC	Seepage, slope.	Seepage, unstable fill, piping.	Not needed	Seepage, erodes easily.	Too sandy, erodes easily, slope.	Erodes easily, slope, droughty.
[2] LgE:						
Lihen part	Seepage, slope.	Seepage, unstable fill, piping.	Not needed	Seepage, erodes easily.	Too sandy, erodes easily, slope.	Erodes easily, slope, droughty.
Zahl part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, percs slowly.	Complex slope, erodes easily.	Slope, erodes easily.
Linton:						
[2] LmB:						
Linton part	Seepage, slope.	Compressible, piping, low strength.	Not needed	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Mandan part	Seepage	Compressible, piping, low strength.	Not needed	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
[2] LmC:						
Linton part	Seepage, slope.	Compressible, piping, low strength.	Not needed	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Mandan part	Seepage	Compressible, piping, low strength.	Not needed	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.

TABLE 9.—*Water management*—Continued

Soil and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
[3] LmD:						
Linton part	Seepage, slope.	Compressible, piping, low strength.	Not needed	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Mandan part	Seepage	Compressible, piping, low strength.	Not needed	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
[3] LmE:						
Linton part	Seepage, slope.	Compressible, piping, low strength.	Not needed	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Mandan part	Seepage	Compressible, piping, low strength.	Not needed	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Lohler:						
[1] Lw, [1] Ly	Favorable	Compressible, hard to pack, shrink-swell.	Poor outlets	Slow intake	Percs slowly	Not needed.
Makoti:						
Mo	Favorable	Compressible, low strength, piping.	Not needed	Slow intake	Piping	Favorable.
Mandan:						
MdA, MdB, MdC	Seepage	Compressible, piping, low strength.	Not needed	Slope, erodes easily.	Slope, erodes easily.	Slope, erodes easily.
Marysland:						
Mf	Seepage	Seepage, piping.	Wetness, floods.	Wetness, floods.	Not needed	Not needed.
Max:						
MgB	Slope	Shrink-swell, low strength.	Not needed	Complex slope.	Complex slope, poor outlets.	Slope, erodes easily.
[3] MhC:						
Max part	Slope	Shrink-swell, low strength.	Not needed	Complex slope.	Complex slope, poor outlets.	Slope, erodes easily.
Bowbells part	Favorable	Shrink-swell, low strength.	Not needed	Slow intake	Poor outlets	Favorable.
Zahl part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, percs slowly.	Complex slope, erodes easily.	Slope, erodes easily.
[3] MlC:						
Max part	Slope	Shrink-swell, low strength.	Not needed	Complex slope.	Complex slope, poor outlets.	Slope, erodes easily.
Zahl part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, percs slowly.	Complex slope, erodes easily.	Slope, erodes easily.
[3] MlD:						
Max part	Slope	Shrink-swell, low strength.	Not needed	Complex slope.	Complex slope, poor outlets.	Slope, erodes easily.
Zahl part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, percs slowly.	Complex slope, erodes easily.	Slope, erodes easily.
Morton:						
MoC	Favorable	Compressible, shrink-swell, piping.	Not needed	Percs slowly, rooting depth.	Piping, rooting depth.	Favorable.

TABLE 9.—*Water management*—Continued

Soil and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Niobell:						
[3] NbA:						
Niobell part	Favorable	Piping, shrink-swell.	Not needed	Percs slowly, excess alkali.	Percs slowly, piping.	Favorable.
Williams part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, slow intake.	Complex slope, poor outlets.	Slope.
[3] NbB:						
Niobell part	Favorable	Piping, shrink-swell.	Not needed	Percs slowly, excess alkali.	Percs slowly, piping.	Favorable.
Williams part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, slow intake.	Complex slope, poor outlets.	Slope.
Noonan:						
[3] NmB:						
Noonan part	Favorable	Piping, shrink-swell, erodes easily.	Not needed	Percs slowly, excess alkali.	Erodes easily, piping.	Erodes easily, excess alkali.
Miranda part	Favorable	Low strength	Excess salt, percs slowly, excess alkali.	Excess salt, percs slowly, excess alkali.	Not needed	Not needed.
[3] NmD:						
Noonan part	Favorable	Piping, shrink-swell, erodes easily.	Not needed	Percs slowly, excess alkali.	Erodes easily, piping.	Erodes easily, excess alkali.
Miranda part	Favorable	Low strength	Excess salt, percs slowly, excess alkali.	Excess salt, percs slowly, excess alkali.	Not needed	Not needed.
Nutley:						
NtA, NtB	Slope	Low strength, compressible.	Not needed	Slope, slow intake, percs slowly.	Slope	Slope, erodes easily.
Orthents:						
Or	Slope	Piping	Not needed	Excess alkali, slope.	Slope	Slope.
Parnell:						
Pa, Pe	Favorable	Low strength, hard to pack.	Floods, percs slowly.	Floods, wetness, slow intake.	Not needed	Not needed.
Parshall:						
PhA, PhB, PhC, PhD, PoA, PoB	Seepage	Seepage, piping.	Not needed	Favorable	Erodes easily, piping.	Erodes easily.
Regent:						
RgC	Favorable	Low strength, compressible, shrink-swell.	Not needed	Rooting depth, slow intake, erodes easily.	Percs slowly, rooting depth, erodes easily.	Erodes easily, percs slowly, rooting depth.
Rhoades:						
[3] RhB	Favorable	Low strength, compressible, hard to pack.	Not needed	Excess alkali, excess salt, slow intake.	Percs slowly, erodes easily, rooting depth.	Erodes easily, excess alkali, excess salt.
Riverwash:						
Rm						
Roseglen:						
Ro	Favorable	Compressible, low strength.	Not needed	Percs slowly	Favorable	Not needed.
[3] RpB:						
Roseglen part	Favorable	Compressible, low strength.	Not needed	Percs slowly	Favorable	Not needed.

TABLE 9.—*Water management*—Continued

Soil and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Tansem part	Seepage	Compressible, low strength, piping.	Not needed	Erodes easily.	Erodes easily.	Favorable.
[a] RpC: Roseglen part	Favorable	Compressible, low strength.	Not needed	Percs slowly	Favorable	Not needed.
Tansem part	Seepage	Compressible, low strength, piping.	Not needed	Erodes easily.	Erodes easily.	Favorable.
Ruso: RsA, RzA	Seepage	Piping, seepage.	Not needed	Complex slope, erodes easily.	Not needed	Droughty, erodes easily.
[a] RtB: Ruso part	Seepage	Piping, seepage.	Not needed	Complex slope, erodes easily.	Not needed	Droughty, erodes easily.
Manning part	Seepage	Seepage	Not needed	Fast intake, seepage.	Erodes easily, rooting depth.	Erodes easily, rooting depth.
[a] RtC: Ruso part	Seepage	Piping, seepage	Not needed	Complex slope, erodes easily.	Not needed	Droughty, erodes easily.
Manning part	Seepage	Seepage	Not needed	Fast intake, seepage.	Erodes easily, rooting depth.	Erodes easily, rooting depth.
[a] RxB: Ruso part	Seepage	Piping, seepage.	Not needed	Complex slope, erodes easily.	Not needed	Droughty, erodes easily.
Manning part	Seepage	Seepage	Not needed	Fast intake, seepage.	Erodes easily, rooting depth.	Erodes easily, rooting depth.
[a] RyC: Ruso part	Seepage	Piping, seepage.	Not needed	Complex slope, erodes easily.	Not needed	Droughty, erodes easily.
Wabek part	Seepage	Seepage	Not needed	Seepage, rooting depth.	Not needed	Droughty, erodes easily.
Seroco: SeD	Seepage	Seepage, piping, erodes easily.	Not needed	Complex slope, soil blowing.	Too sandy, erodes easily, slope.	Droughty, erodes easily, slope.
Sinai: Sn	Favorable	Low strength, compressible, shrink-swell.	Not needed	Slow intake, percs slowly.	Not needed	Droughty.
Straw: St, [a] Sx	Seepage	Low strength, hard to pack, piping.	Floods, slope	Seepage, floods, slope.	Slope, piping, erodes easily.	Slope, erodes easily.
Telfer: [a] TlC: Telfer part	Seepage	Seepage, piping, erodes easily.	Not needed	Complex slope, soil blowing.	Too sandy, erodes easily, slope.	Droughty, erodes easily.
Lihen part	Seepage, slope.	Seepage, unstable fill, piping.	Not needed	Seepage, erodes easily.	Too sandy, erodes easily, slope.	Erodes easily, slope, droughty.

TABLE 9.—*Water management*—Continued

Soil and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
Tonka:						
[2] Tp:						
Tonka part	Favorable	Low strength, shrink-swell.	Poor outlets	Wetness	Wetness	Not needed.
Parnell part	Favorable	Low strength, hard to pack.	Floods, percs slowly.	Floods, wetness, slow intake.	Not needed	Not needed.
Trembles:						
[1] Tr	Seepage	Piping	Not needed	Erodes easily.	Piping, erodes easily.	Erodes easily.
Vebar:						
[2] VwC:						
Vebar part	Seepage, depth to rock.	Piping	Not needed	Erodes easily, rooting depth.	Depth to rock.	Erodes easily, slope.
Williams part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, slow intake.	Complex slope, poor outlets.	Slope.
Wabek:						
[2] WaB:						
Wabek part	Seepage	Seepage	Not needed	Droughty, seepage, rooting depth.	Not needed	Droughty, erodes easily.
Max part	Slope	Shrink-swell, low strength.	Not needed	Complex slope.	Complex slope, poor outlets.	Slope, erodes easily.
Zahl part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, percs slowly.	Complex slope, erodes easily.	Slope, erodes easily.
[2] WaD:						
Wabek part	Seepage	Seepage	Not needed	Seepage, rooting depth.	Not needed	Droughty, erodes easily.
Max part	Slope	Shrink-swell, low strength.	Not needed	Complex slope.	Complex slope, poor outlets.	Slope, erodes easily.
Zahl part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, percs slowly.	Complex slope, erodes easily.	Slope, erodes easily.
[2] WbB, [2] WbD	Seepage	Seepage	Not needed	Seepage, rooting depth.	Not needed	Droughty, erodes easily.
Williams:						
WlB	Favorable	Large stones	Not needed	Large stones, complex slope, slow intake.	Large stones, complex slope, poor outlets.	Large stones, slope.
WmA, WmB	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, slow intake.	Complex slope, poor outlets, slow intake.	Slope.
[2] WoA:						
Williams part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, slow intake.	Complex slope, poor outlets.	Slope.
Bowbells part	Favorable	Shrink-swell, low strength.	Not needed	Slow intake	Poor outlets	Favorable.
[2] WoB:						
Williams part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, slow intake.	Complex slope, poor outlets.	Slope.
Bowbells part	Favorable	Shrink-swell, low strength.	Not needed	Slow intake	Poor outlets	Favorable.

TABLE 9.—*Water management*—Continued

Soil and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
[3] WoC:						
Williams part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, slow intake.	Complex slope, poor outlets.	Slope.
Bowbells part	Favorable	Shrink-swell, low strength.	Not needed	Slow intake	Poor outlets	Favorable.
[3] WpB:						
Williams part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, slow intake.	Complex slope, poor outlets.	Slope.
Bowbells part	Favorable	Shrink-swell, low strength.	Not needed	Slow intake	Poor outlets	Favorable.
Zahl part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, percs slowly.	Complex slope, erodes easily.	Slope, erodes easily.
[3] WrB:						
Williams part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, slow intake.	Complex slope, poor outlets.	Slope.
Mine sink part.						
Wilton:						
WsA	Favorable	Compressible, piping.	Not needed	Complex slope, percs slowly.	Complex slope.	Favorable.
[3] WtB:						
Wilton part	Favorable	Compressible, piping.	Not needed	Complex slope, percs slowly.	Complex slope.	Favorable.
Temvik part	Favorable	Compressible, shrink-swell, piping.	Not needed	Percs slowly, complex slope.	Complex slope, piping.	Favorable.
[3] WwC:						
Wilton part	Favorable	Compressible, piping.	Not needed	Complex slope, percs slowly.	Complex slope.	Favorable.
Williams part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, slow intake.	Complex slope, poor outlets.	Slope.
Zahl:						
[3] ZcE:						
Zahl part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, percs slowly.	Complex slope, erodes easily.	Slope, erodes easily.
Cabba part	Slope, seepage, depth to rock.	Thin layer, piping, low strength.	Not needed	Complex slope, rooting depth.	Depth to rock, slope, rooting depth.	Rooting depth, slope, droughty.
[3] ZmE:						
Zahl part	Favorable	Compressible, shrink-swell, low strength.	Not needed	Complex slope, percs slowly.	Complex slope, erodes easily.	Slope, erodes easily.
Max part	Slope	Shrink-swell, low strength.	Not needed	Complex slope.	Complex slope, poor outlets.	Slope, erodes easily.
[3] ZpE:						
Zahl part	Favorable	Compressible, shrink-swell, low strength.	Not needed	Complex slope, percs slowly.	Complex slope, erodes easily.	Slope, erodes easily.
Max part	Slope	Shrink-swell, low strength.	Not needed	Complex slope.	Complex slope, poor outlets.	Slope, erodes easily.
Parnell part	Favorable	Low strength, hard to pack.	Floods, percs slowly, frost action.	Floods, wetness, slow intake.	Not needed	Not needed.

TABLE 9.—*Water management*—Continued

Soil and map symbol	Pond reservoir areas	Embankments, dikes, and levees	Drainage	Irrigation	Terraces and diversions	Grassed waterways
[2] ZwC:						
Zahl part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, percs slowly.	Complex slope, erodes easily.	Slope, erodes easily.
Williams part	Favorable	Shrink-swell, low strength.	Not needed	Complex slope, slow intake.	Complex slope, poor outlets.	Slope.

[1] Protected from flooding by Garrison Dam.
[2] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

flow area surrounded by cut slopes or embankments of compacted, nearly impervious soil material. Aerobic lagoons generally are designed so that depth of the sewage is 2 to 5 feet. Impervious soil for the lagoon floor and sides is required to minimize seepage and contamination of local ground water. Soils that are very high in organic matter and those that have stones and boulders are undesirable. Unless the soil has very slow permeability, contamination of local ground water is a hazard in areas where the seasonal high water table is above the level of the lagoon floor. In soils where the water table is seasonally high, seepage of ground water into the lagoon can seriously reduce its capacity for liquid waste. Slope, depth to bedrock, and susceptibility to flooding also affect the location of sites for sewage lagoons or the cost of construction. Shear strength and permeability of compacted soils affect the performance of embankments.

Sanitary landfill is a method of disposing of solid waste, either in excavated trenches or on the surface of the soil. The waste is spread compacted in layers and covered with thin layers of soil. Landfill areas are subject to heavy vehicular traffic. Ease of excavation, risk of polluting ground water, and trafficability affect the suitability of a soil for this purpose. The best soils have a loamy or silty texture, have moderate or slow permeability, are deep to bedrock and a seasonal water table, are free of large stones and boulders, and are not subject to flooding. In areas where the seasonal water table is high, water seeps into the trenches and causes problems in excavating and filling the trenches. Also, seepage into the refuse increases the risk of pollution of ground water. Clayey soils are likely to be sticky and difficult to spread. Sandy or gravelly soils generally have rapid permeability that might allow noxious liquids to contaminate local ground water.

Unless otherwise stated, the ratings in table 8 apply only to soil properties and features within a depth of about 6 feet. If the trench is deeper, ratings of slight or moderate may not be valid. Site investigation is needed before a site is selected.

In the area type of sanitary landfill, refuse is placed on the surface of the soil in successive layers. The limitations caused by soil texture, depth to bedrock, and stone content do not apply to this type of landfill. Soil wetness, however, may be a limitation because of difficulty in operating equipment.

Daily cover for sanitary landfill should be soil that is easy to excavate and spread over the compacted fill during both wet and dry weather. Soils that are loamy or silty and free of stones or boulders are better than other soils. Clayey soils may be sticky and difficult to spread; sandy soils may be subject to soil blowing.

In addition to these features, the soils selected for final cover of landfills should be suitable for growing plants. In comparison with other horizons, the A horizon in most soils has the best workability, more organic matter, and the best potential for growing plants. Thus, for either the area- or trench-type landfill, stockpiling material from the A horizon for use as the surface layer of the final cover is desirable.

Where it is necessary to bring in soil material for daily or final cover, thickness of suitable soil material available and depth to a seasonal high water table in soils surrounding the sites should be evaluated. Other factors to be evaluated are those that affect reclamation of the borrow areas, such as slope, erodibility, and potential for plant growth.

Water management

Many soil properties and site features that affect water management practices have been identified in this soil survey. In table 9 soil and site features that affect use are indicated for each kind of soil. This information is significant in planning, installing, and maintaining water control structures.

Pond reservoir areas hold water behind a dam or embankment. Soils suitable for this use have low seepage potential, which is determined by the permeability and depth over fractured or permeable bedrock or other permeable material.

Embankments, dikes, and levees require soil material that is resistant to seepage, erosion, and piping and is of favorable stability, shrink-swell potential, shear strength, and compaction characteristics. Stones and organic matter in a soil downgrade the suitability of a soil for use in embankments, dikes, and levees.

Drainage of soil is affected by such soil properties as permeability, texture, structure, depth to claypan or other layers that influence rate of water movement, depth to the water table, slope, stability of ditchbanks, susceptibility to flooding, salinity and alkalinity, and availability of outlets for drainage.

Irrigation is affected by such features as slope, susceptibility to flooding, hazards of water erosion and soil blowing, texture, presence of salts and alkali, depth of root zone, rate of water intake at the surface, permeability of the soil below the surface layer, avail-

TABLE 10.—*Construction material*

[Terms that describe restrictive soil features are defined in the Glossary. See text for definitions of "good," "fair," "poor," and "unsuited." Absence of an entry indicates that the soil was not rated]

Soil and map symbol	Road fill	Sand	Gravel	Topsoil
Aquents: Ac	Poor: frost action	Unsuited	Unsuited	Poor: thin layer.
Aquolls: AF	Poor: wetness	Unsuited	Unsuited	Poor: wetness.
Arnegard: ArA, ArB, ArC	Fair: frost action	Unsuited	Unsuited	Good.
Banks: Ba	Good	Poor: excess fines	Unsuited	Poor: too sandy.
Bk	Good	Poor: excess fines	Unsuited	Poor: thin layer.
Bowbells: BoA	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
[1] BsB: Bowbells part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
Williams part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Good.
Bowdle: BwA	Good	Fair: excess fines	Fair: excess fines	Good.
[1] ByB: Bowdle part	Good	Fair: excess fines	Fair: excess fines	Good.
Stady part	Good	Fair: excess fines	Fair: excess fines	Good.
[1] ByC: Bowdle part	Good	Fair: excess fines	Fair: excess fines	Good.
Stady part	Good	Fair: excess fines	Fair: excess fines	Good.
Cabba: [1] CaE	Poor: slope	Unsuited	Unsuited	Poor: slope.
[1] CbF: Cabba part	Poor: slope	Unsuited	Unsuited	Poor: slope.
Shale outcrop part.				
Cohagen: [1] ChD: Cohagen part	Fair: frost action	Unsuited	Unsuited	Poor: thin layer.
Vebar part	Good	Poor: excess fines	Unsuited	Fair: slope.
[1] ChE: Cohagen part	Poor: slope	Unsuited	Unsuited	Poor: thin layer, slope.
Vebar part	Good	Poor: excess fines	Unsuited	Poor: slope.
Colvin: Co	Poor: wetness, frost action.	Unsuited	Unsuited	Poor: wetness.
Dimmick: Dm	Poor: wetness, shrink-swell.	Unsuited	Unsuited	Poor: wetness, too clayey.
Divide: Dv	Fair: wetness, frost action.	Poor: excess fines	Poor: excess fines	Good.
Falkirk: FaA, FaB	Fair: low strength, frost action.	Unsuited	Unsuited	Good.

TABLE 10.—*Construction material*—Continued

Soil and map symbol	Road fill	Sand	Gravel	Topsoil
[1] FbA:				
Falkirk part	Fair: low strength, frost action.	Unsuited	Unsuited	Good.
Max part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
[1] FbB:				
Falkirk part	Fair: low strength, frost action.	Unsuited	Unsuited	Good.
Max part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
[1] FbC:				
Falkirk part	Fair: low strength, frost action.	Unsuited	Unsuited	Good.
Max part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
Farnuf:				
FfA, FfB	Fair: shrink-swell, frost action, low strength.	Unsuited	Unsuited	Good.
Flasher:				
FlD	Good	Unsuited	Unsuited	Poor: thin layer.
FlE	Poor: slope	Unsuited	Unsuited	Poor: thin layer.
Flaxton:				
FnA, FnB, FnC	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Good.
Fossum:				
Fs	Poor: wetness	Fair: excess fines	Unsuited	Poor: wetness.
Grail:				
GaA, GaB	Fair: frost action	Unsuited	Unsuited	Fair: too clayey.
Grano:				
Gn	Poor: wetness, shrink-swell.	Unsuited	Unsuited	Poor: wetness.
Grassna:				
GoA	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
Hamerly:				
HaA	Poor: frost action	Unsuited	Unsuited	Fair: thin layer.
Harriet:				
[1] Hk:				
Harriet part	Poor: wetness, low strength.	Unsuited	Unsuited	Poor: wetness, excess salt, excess alkali.
Saline land part.				
Havrelon:				
Hn	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
Ho	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Fair: too clayey.
Heil:				
Hs	Poor: wetness, shrink-swell.	Unsuited	Unsuited	Poor: wetness, too clayey.
Krem:				
KrB	Fair: shrink-swell	Unsuited	Unsuited	Poor: too sandy.

TABLE 10.—*Construction material*—Continued

Soil and map symbol	Road fill	Sand	Gravel	Topsoil
Lallie:				
La	Poor: wetness, frost action.	Unsuited	Unsuited	Poor: wetness.
Lihen:				
LeB, LeC	Good	Poor: excess fines	Unsuited	Poor: too sandy.
[1] LgE:				
Lihen part	Fair: slope	Poor: excess fines	Unsuited	Poor: slope, too sandy.
Zahl part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Poor: slope.
Linton:				
[1] LmB:				
Linton part	Fair: low strength, frost action.	Unsuited	Unsuited	Good.
Mandan part	Fair: low strength, frost action.	Unsuited	Unsuited	Good.
[1] LmC:				
Linton part	Fair: low strength, frost action.	Unsuited	Unsuited	Good.
Mandan part	Fair: low strength, frost action.	Unsuited	Unsuited	Good.
[1] LmD:				
Linton part	Fair: low strength, frost action.	Unsuited	Unsuited	Fair: slope.
Mandan part	Fair: low strength, frost action.	Unsuited	Unsuited	Fair: slope.
[1] LmE:				
Linton part	Poor: slope	Unsuited	Unsuited	Poor: slope.
Mandan part	Poor: slope	Unsuited	Unsuited	Poor: slope.
Lohler:				
Lw	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: thin layer.
Ly	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: too clayey.
Makoti:				
Ma	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Fair: too clayey.
Mandan:				
MdA, MdB, MdC	Fair: low strength, frost action.	Unsuited	Unsuited	Good.
Marysland:				
Mf	Poor: wetness, frost action.	Fair: excess fines	Poor: excess fines	Poor: wetness.
Max:				
MgB	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
[1] MhC:				
Max part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
Bowbells part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
Zahl part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Good.

TABLE 10.—*Construction material*—Continued

Soil and map symbol	Road fill	Sand	Gravel	Topsoil
[1] MlC:				
Max part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
Zahl part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Good.
[1] MlD:				
Max part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Fair: slope.
Zahl part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Fair: slope.
Morton:				
MoC	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Fair: too clayey.
Niobell:				
[1] NbA:				
Niobell part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Fair: thin layer.
Williams part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Good.
[1] NbB:				
Niobell part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Fair: thin layer.
Williams part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Good.
Noonan:				
[1] NmB:				
Noonan part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Poor: thin layer.
Miranda part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Poor: thin layer.
[1] NmD:				
Noonan part	Fair: shrink-swell	Unsuited	Unsuited	Poor: thin layer.
Miranda part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Poor: thin layer.
Nutley:				
NtA NtB	Poor: low strength, shrink-swell.	Unsuited	Unsuited	Poor: too clayey.
Orthents:				
Or	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Poor: excess alkali.
Parnell:				
Pa, Pe	Poor: wetness, shrink-swell, frost action.	Unsuited	Unsuited	Poor: wetness.
Parshall:				
PhA, PhB, PhC, PoA, PoB	Fair: frost action	Poor: excess fines	Unsuited	Good.
PhD	Fair: frost action	Poor: excess fines	Unsuited	Fair: slope.
Regent:				
RgC	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Fair: too clayey, thin layer.
Rhoades:				
[1] RhB	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: thin layer, excess alkali, area reclaim.

TABLE 10.—*Construction material*—Continued

Soil and map symbol	Road fill	Sand	Gravel	Topsoil
Riverwash: Rm.				
Roseglen: Ro	Fair: low strength, shrink-swell, frost action.	Unsuited	Unsuited	Good.
[1] RpB: Roseglen part	Fair: low strength, shrink-swell, frost action.	Unsuited	Unsuited	Good.
Tansem part	Fair: frost action, low strength, shrink-swell.	Unsuited	Unsuited	Good.
[1] RpC: Roseglen part	Fair: low strength, shrink-swell, frost action.	Unsuited	Unsuited	Good.
Tansem part	Fair: frost action, low strength, shrink-swell.	Unsuited	Unsuited	Good.
Ruso: RsA, RzA	Good	Poor: excess fines	Poor: excess fines	Fair: area reclaim.
[1] RtB: Ruso part	Good	Poor: excess fines	Poor: excess fines	Fair: area reclaim.
Manning part	Good	Poor: excess fines	Poor: excess fines	Fair: area reclaim.
[1] RtC: Ruso part	Good	Poor: excess fines	Poor: excess fines	Fair: area reclaim.
Manning part	Good	Poor: excess fines	Poor: excess fines	Fair: area reclaim.
[1] RxB: Ruso part	Good	Poor: excess fines	Poor: excess fines	Fair: area reclaim.
Manning part	Good	Poor: excess fines	Poor: excess fines	Fair: area reclaim.
[1] RyC: Ruso part	Good	Poor: excess fines	Poor: excess fines	Fair: area reclaim.
Wabek part	Good	Fair: excess fines	Fair: excess fines	Poor: thin layer, area reclaim.
Seroco: SeD	Fair: slope	Poor: excess fines	Unsuited	Poor: too sandy.
Sinai: Sn	Poor: shrink-swell, low strength.	Unsuited	Unsuited	Poor: too clayey.
Straw: St	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
[1] Sx	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
Telfer: [1] TlC: Telfer part	Good	Poor: excess fines	Unsuited	Poor: too sandy.
Lihen part	Good	Poor: excess fines	Unsuited	Poor: too sandy.
Tonka: [1] Tp: Tonka part	Poor: wetness	Unsuited	Unsuited	Poor: wetness.

TABLE 10.—*Construction material*—Continued

Soil and map symbol	Road fill	Sand	Gravel	Topsoil
Parnell part	Poor: wetness, shrink-swell, frost action.	Unsuited	Unsuited	Poor: wetness.
Trembles:				
Tr	Fair: frost action, low strength.	Unsuited	Unsuited	Good.
Vebar:				
[1] VwC:				
Vebar part	Good	Poor: excess fines	Unsuited	Good.
Williams part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Good.
Wabek:				
[1] WaB:				
Wabek part	Good	Fair: excess fines	Fair: excess fines	Poor: thin layer, area reclaim.
Max part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
Zahl part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Good.
[1] WaD:				
Wabek part	Good	Fair: excess fines	Fair: excess fines	Poor: thin layer, area reclaim.
Max part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Fair: slope.
Zahl part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Fair: slope.
[1] WbB, [1] WbD	Good	Fair: excess fines	Fair: excess fines	Poor: thin layer, area reclaim.
Williams:				
WlB	Fair: frost action, shrink-swell, large stones.	Unsuited	Unsuited	Poor: large stones.
WmA, WmB	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Fair: too clayey.
[1] WoA:				
Williams part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Good.
Bowbells part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
[1] WoB:				
Williams part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Good.
Bowbells part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
[1] WoC:				
Williams part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Good.
Bowbells part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
[1] WpB:				
Williams part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Good.

TABLE 10.—*Construction material*—Continued

Soil and map symbol	Road fill	Sand	Gravel	Topsoil
Bowbells part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Good.
Zahl part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Good.
[1] WrB: Williams part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Good.
Mine sink part.				
Wilton: WsA	Fair: frost action, low strength.	Unsuited	Unsuited	Good.
[1] WtB: Wilton part	Fair: frost action, low strength.	Unsuited	Unsuited	Good.
Temvik part	Fair: low strength, frost action.	Unsuited	Unsuited	Good.
[1] WwC: Wilton part	Fair: frost action, low strength.	Unsuited	Unsuited	Good.
Williams part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Good.
Zahl: [1] ZcE: Zahl part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Poor: slope.
Cabba part	Poor: slope	Unsuited	Unsuited	Poor: slope.
[1] ZmE: Zahl part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Poor: slope.
Max part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Poor: slope.
[1] ZpE: Zahl part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Poor: slope.
Max part	Fair: shrink-swell, frost action.	Unsuited	Unsuited	Poor: slope.
Parnell part	Poor: wetness, shrink-swell, frost action.	Unsuited	Unsuited	Poor: wetness.
[1] ZwC: Zahl part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Good.
Williams part	Fair: frost action, shrink-swell.	Unsuited	Unsuited	Good.

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

able water capacity, need for drainage, and depth to the water table.

Terraces and diversions are embankments, or a combination of channels and ridges, constructed across a slope to intercept runoff and allow the water to soak into the soil or flow slowly to an outlet. Features that affect suitability of a soil for terraces are uniformity of slope and steepness, depth to bedrock or other unfavorable material, permeability, ease of establishing vegetation, and resistance to water erosion, soil blowing, soil slipping, and piping.

Grassed waterways are constructed to channel runoff at nonerosive velocities to outlets. Features that affect the use of soils for waterways are slope, perme-

ability, erodibility, and suitability for permanent vegetation.

Construction material

The suitability of each soil as a source of road fill, sand, gravel, and topsoil is indicated in table 10 by ratings of good, fair, or poor. The texture, thickness, and organic-matter content of each soil horizon are important factors in rating soils for use as construction materials. Each soil is evaluated to the depth observed and described as the survey is made, generally about 6 feet.

Road fill is soil material used in embankments for roads. The ratings reflect the ease of excavating and working the material and the expected performance of the material after it has been compacted and adequately drained. The performance of soil after it is stabilized with lime or cement is not considered in the ratings, but information about soil properties that determine such performance is given in the descriptions of soil series.

The ratings apply to the soil profile between the A horizon and a depth of 5 to 6 feet. It is assumed that soil horizons will be mixed during excavation and spreading. Many soils have horizons of contrasting suitability within the profile. The estimated engineering properties in table 11 provide more specific information about the nature of each horizon that can help determine its suitability for road fill.

According to the Unified soil classification system, soils rated *good* have low shrink-swell potential, low potential frost action, and few cobbles and stones. They are at least moderately well drained and have slopes of 15 percent or less. Soils rated *fair* have a plasticity index of less than 15 and have other limiting features, such as high shrink-swell potential, high potential frost action, steep slopes, wetness, or many stones. If the thickness of suitable material is less than 3 feet, the entire soil is rated *poor,* regardless of the quality of the suitable material.

Sand and gravel are used in great quantities in many kinds of construction. The ratings in table 10 provide guidance as to where to look for probable sources and are based on the probability that soils in a given area contain sizable quantities of sand or gravel. A soil rated *good* or *fair* has a layer of suitable material at least 3 feet thick, the top of which is within a depth of 6 feet. Coarse fragments of soft bedrock material, such as shale and siltstone, are not considered to be sand and gravel. Fine-grained soils are not suitable sources of sand and gravel.

The ratings do not take into account depth to the water table or other factors that affect excavation of the material. Descriptions of grain size, kinds of minerals, reaction, and stratification are given in the soil series descriptions and in table 11.

Topsoil is used in areas where vegetation is to be established and maintained. Suitability is affected mainly by the ease of working and spreading the soil material in preparing a seedbed and by the ability of the soil material to sustain the growth of plants. Also considered is the damage that would result to the area from which the topsoil is taken.

Soils rated *good* have at least 16 inches of friable loamy material at their surface. They are free of stones, are low in content of gravel and other coarse fragments, and have gentle slopes. They are low in soluble salts, which can limit plant growth. They are naturally fertile or respond well to fertilization. They are not so wet that excavation is difficult during most of the year.

Soils rated *fair* are loose sandy or firm loamy or clayey soils in which the suitable material is only 8 to 16 inches thick or soils that have appreciable amounts of gravel, stones, or soluble salt.

Soils rated *poor* are very sandy soils, very firm clayey soils, soils with suitable layers less than 8 inches thick, soils having large amounts of gravel, stones or soluble salt, steep soils, and poorly drained soils.

Although a rating of *good* is not based entirely on high content of organic matter, a surface horizon is much preferred for topsoil because of its organic-matter content. This horizon is designated as A1 or Ap in the soil series descriptions. The absorption and retention of moisture and nutrients for plant growth are greatly increased by organic matter. Consequently, careful preservation and use of material from these horizons is desirable.

Soil Properties

Extensive data about soil properties collected during the soil survey are summarized on the following pages. The two main sources of these data are the many thousands of soil borings made during the course of the survey and the laboratory analyses of samples selected from representative soil profiles in the field.

When he makes soil borings during field mapping, the soil scientist can identify several important soil properties. He notes the seasonal soil moisture condition, or the presence of free water and its depth in the profile. For each horizon, he notes the thickness of the soil and its color; the texture, or the amount of clay, silt, sand, and gravel or other coarse fragments; the structure, or natural pattern of cracks and pores in the undisturbed soil; and the consistence of soil in-place under the existing soil moisture conditions. He records the root depth of existing plants, determines soil pH or reaction, and identifies any free carbonates.

Samples of soil material are analyzed in the laboratory to verify the field estimates of soil properties and to characterize key soils, especially properties that cannot be estimated accurately by field observation. Laboratory analyses are not conducted for all soil series in the survey area, but laboratory data for many of the soil series are available from nearby areas.

Based on summaries of available field and laboratory data, and listed in tables in this section, are estimated ranges in engineering properties and classifications and in physical and chemical properties for each major horizon of each soil in the survey area. Also, pertinent soil and water features, engineering test data, and data obtained from laboratory analyses, both physical and chemical, are presented.

Engineering properties

Table 11 gives estimates of engineering properties

TABLE 11.—*Engineering properties*

[The symbol < means less than; > means greater than.

Soil and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Aquents: Ac.				
Aquolls: Af.				
Arnegard: ArA, ArB, ArC	0–6	Loam	ML	A–4
	6–60	Fine sandy loam, loam, clay loam	SM, ML, CL	A–4, A–6
Banks: Ba	0–4	Loamy fine sand	SM	A–2, A–4
	4–60	Loamy fine sand, fine sand, sand	SM	A–2
Bk	0–6	Loam	SM, ML	A–4
	6–60	Loamy fine sand, fine sand, sand	SM	A–2
Bowbells: BoA	0–9	Loam	CL, ML	A–4, A–6
	9–25	Loam, clay loam	CL	A–6, A–7
	25–60	Loam, clay loam	CL	A–6, A–7
[1] BsB: Bowbells part	0–9	Loam	CL, ML	A–4, A–6
	9–25	Loam, clay loam	CL	A–6, A–7
	25–60	Loam, clay loam	CL	A–6, A–7
Williams part	0–5	Loam	CL, ML	A–4, A–6, A–7
	5–16	Clay loam, loam	CL	A–6, A–7
	16–60	Clay loam, loam	CL	A–6, A–7
Bowdle: BwA	0–7	Loam	ML, CL	A–6, A–4
	7–32	Clay loam, loam	CL, ML	A–4, A–6
	32–48	Gravelly loamy sand	SM, GM, SP–SM, GP–GM	A–1, A–2
[1] ByB: Bowdle part	0–7	Loam	ML, CL	A–6, A–4
	7–32	Clay loam, loam	CL, ML	A–4, A–6
	32–60	Gravelly loamy sand	SM, GM, SP–SM, GP–GM	A–1, A–2
Stady part	0–9	Loam	ML, CL	A–4, A–6
	9–25	Loam	ML, CL	A–4, A–6
	25–60	Very gravelly sand	SM, SP, GM, GP	A–1
[1] ByC: Bowdle part	0–7	Loam	ML, CL	A–6, A–4
	7–32	Clay loam, loam	CL, ML	A–4, A–6
	32–60	Gravelly loamy sand	SM, GM, SP–SM, GP–GM	A–1, A–2
Stady part	0–9	Loam	ML, CL	A–4, A–6
	9–25	Loam	ML, CL	A–4, A–6
	25–60	Very gravelly sand	SM, SP, GM, GP	A–1
Cabba: [1] CaE	0–17	Loam	CL, ML	A–4, A–6
	17–60	Weathered bedrock.		
[1] CbF: Cabba part	0–17	Loam	CL, ML	A–4, A–6
	17–60	Weathered bedrock.		
Shale outcrop part.				

and classifications

Absence of an entry indicates that data were not estimated]

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	100	85–100	60–90	20–40	NP–10
0	100	100	70–95	40–80	10–40	NP–20
0	100	100	60–80	10–40		NP
0	100	100	50–70	10–25		NP
0	100	100	80–95	45–75	10–40	NP–10
0	100	100	50–70	10–25		NP
0–5	95–100	90–100	85–95	60–90	20–40	5–25
0–5	95–100	90–100	80–95	60–80	20–45	10–25
0–5	95–100	90–100	80–95	60–80	20–45	10–25
0–5	95–100	90–100	85–95	60–90	20–40	5–25
0–5	95–100	90–100	80–95	60–80	20–45	10–25
0–5	95–100	90–100	80–95	60–80	20–45	10–25
0–5	95–100	95–100	85–95	60–90	25–45	5–30
0–5	95–100	95–100	80–95	60–80	30–50	10–30
0–5	95–100	95–100	80–95	60–80	30–50	10–30
0	100	95–100	85–95	60–85	25–40	3–18
0	100	95–100	80–95	60–80	25–40	3–18
0	40–80	25–75	15–70	5–30	<30	NP–5
0	100	95–100	85–95	60–85	25–40	3–18
0	100	95–100	80–95	60–80	25–40	3–18
0	40–80	25–75	15–70	5–30	<30	NP–5
0–1	95–100	95–100	85–95	60–75	25–40	5–15
0–1	95–100	95–100	85–95	60–75	25–40	5–15
0–1	95–100	50–95	10–30	2–15		NP
0	100	95–100	85–95	60–85	25–40	3–18
0	100	95–100	80–95	60–80	25–40	3–18
0	40–80	25–75	15–70	5–30	<30	NP–5
0–1	95–100	95–100	85–95	60–75	25–40	5–15
0–1	95–100	95–100	85–95	60–75	25–40	5–15
0–1	50–100	50–95	10–30	2–15		NP
0–5	95–100	85–100	75–90	60–80	20–40	5–15
0–5	95–100	85–100	75–90	60–80	20–40	5–15

TABLE 11.—*Engineering properties*

Soil and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Cohagen:				
[1] ChD:				
Cohagen part	0–18	Fine sandy loam	SM	A-2, A-4
	18–60	Weathered bedrock.		
Vebar part	0–38	Fine sandy loam	SM, ML	A-4, A-2
	38–60	Weathered bedrock.		
[1] ChE:				
Cohagen part	0–18	Fine sandy loam	SM	A-2, A-4
	18–60	Weathered bedrock.		
Vebar part	0–38	Fine sandy loam	SM, ML	A-4, A-2
	38–60	Weathered bedrock.		
Colvin:				
Co	0–60	Silty clay loam, clay loam	CL	A-6, A-7
Dimmick:				
Dm	0–60	Clay	CH	A-7
Divide:				
Dv	0–5	Loam	ML, CL	A-4, A-6
	5–28	Loam, clay loam, gravelly loam	ML, CL	A-4, A-6
	28–60	Gravelly sand, very gravelly sand	GM, SM, GP-GM, SP-SM	A-1
Falkirk:				
FaA, FaB	0–28	Loam	ML, CL	A-4
	28–34	Gravelly loam	ML, SM, CL, SC	A-4
	34–60	Loam, clay loam	ML, CL	A-4, A-6, A-7
[1] FbA:				
Falkirk part	0–28	Loam	ML, CL	A-4
	28–34	Gravelly loam	ML, SM, CL, SC	A-4
	34–60	Loam, clay loam	ML, CL	A-4, A-6, A-7
Max part	0–17	Loam	ML, CL	A-4, A-6, A-7
	17–60	Loam, clay loam	ML, CL	A-4, A-6, A-7
[1] FbB:				
Falkirk part	0–28	Loam	ML, CL	A-4
	28–34	Gravelly loam	ML, SM, CL, SC	A-4
	34–60	Loam, clay loam	ML, CL	A-4, A-6, A-7
Max part	0–17	Loam	ML, CL	A-4, A-6, A-7
	17–60	Loam, clay loam	ML, CL	A-4, A-6, A-7
[1] FbC:				
Falkirk part	0–28	Loam		A-4
	28–34	Gravelly loam	ML, SM, CL, SC	A-4
	34–60	Loam, clay loam	ML, CL	A-4, A-6, A-7
Max part	0–17	Loam	ML, CL	A-4, A-6, A-7
	17–60	Loam, clay loam	ML, CL	A-4, A-6, A-7
Farnuf:				
FfA, FfB	0–3	Loam	ML, CL-ML, CL	A-4
	3–36	Clay loam, loam	ML, CL, CL-ML	A-4, A-6
	36–60	Stratified fine sandy loam to loam	ML, SM	A-4
Flasher:				
FlD, FlE	0–9	Fine sandy loam	SM	A-2, A-4
	9–17	Loamy sand, loamy fine sand, fine sand	SM	A-2
	17–60	Weathered bedrock.		
Flaxton:				
FnA FnB FnC	0–10	Fine sandy loam	SM	A-2, A-4
	10–31	Fine sandy loam	SM	A-2, A-4
	31–60	Clay loam, loam	CL, CL-ML	A-4, A-6, A-7

and classifications—Continued

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	95–100	60–85	30–50	----------------	NP
0	100	100	60–85	30–55	----------------	NP
0	100	95–100	60–85	30–50	----------------	NP
0	100	100	60–85	30–55	----------------	NP
0	100	100	90–100	80–95	20–50	11–30
0	100	100	90–100	75–95	50–70	25–45
0 0–3 0–5	95–100 95–100 25–75	95–100 80–100 15–65	85–95 60–90 10–40	60–85 55–80 5–25	25–40 25–40 ----------------	5–20 5–20 NP
0 0–5 0–5	100 65–95 90–100	100 65–90 85–100	85–95 55–80 80–95	60–75 40–70 60–80	20–40 20–40 25–50	NP–10 NP–10 5–30
0 0–5 0–5	100 65–95 90–100	100 65–90 85–100	85–95 55–80 80–95	60–75 40–70 60–80	20–40 20–40 25–50	NP–10 NP–10 5–30
0–3 0–3	100 100	95–100 95–100	85–95 85–100	60–75 60–80	25–45 25–45	5–25 5–25
0 0–5 0–5	100 65–95 90–100	100 65–90 85–100	85–95 55–80 80–95	60–75 40–70 60–80	20–40 20–40 25–50	NP–10 NP–10 5–30
0–3 0–3	100 100	95–100 95–100	85–95 85–100	60–75 60–80	25–45 25–45	5–25 5–25
0 0–5 0–5	100 65–95 90–100	100 65–90 85–100	85–95 55–80 80–95	60–75 40–70 60–80	20–40 20–40 25–50	NP–10 NP–10 5–30
0–3 0–3	100 100	95–100 95–100	85–95 85–100	60–75 60–80	25–45 25–45	5–25 5–25
0 0 0	90–100 90–100 90–100	90–100 80–100 80–100	75–100 70–100 75–95	55–90 50–80 45–65	20–30 20–40 10–20	NP–10 3–23 NP–5
0–5 0–5	100 100	95–100 95–100	60–85 50–80	30–50 15–35	---------------- ----------------	NP NP
0–1 0–1 0–5	100 100 95–100	100 100 95–100	50–85 60–85 85–95	20–45 30–45 60–80	---------------- ---------------- 25–45	NP NP 5–25

TABLE 11.—*Engineering properties*

Soil and map symbol	Depth	USDA texture	Classification: Unified	Classification: AASHTO
	In			
Fossum:				
Fs	0–6	Fine sandy loam	SM, SC	A–4
	6–18	Loamy sand, sand, loamy fine sand	SM, SP–SM	A–2, A–3
	18–60	Sand, fine sand	SP–SM, SM	A–3, A–2
Grail:				
GaA, GaB	0–11	Silty clay loam	CL	A–6, A–7
	11–20	Silty clay	CL	A–7
	20–60	Loam, clay loam, silty clay loam	ML, CL	A–4, A–6, A–7
Grano:				
Gn	0–17	Silty clay	CH	A–7
	17–48	Silty clay, clay	CH	A–7
	48–60	Clay loam, silty clay, clay	CL, CH	A–7
Grassna:				
GoA	0–17	Silt loam	ML, CL	A–4, A–6, A–7
	17–60	Silt loam, silty clay loam	ML, CL	A–4, A–6, A–7
Hamerly:				
HaA	0–6	Loam	CL, ML	A–4, A–6
	6–35	Loam, clay loam	CL, ML	A–4, A–6, A–7
	35–60	Loam, clay loam	CL, ML	A–4, A–6, A–7
Harriet:				
[1] Hk:				
Harriet part	0–2	Very fine sandy loam	ML	A–4
	2–11	Clay loam, silty clay loam, clay	CL, CH	A–7, A–6
	11–60	Fine sandy loam, loam, clay loam, silty clay.	ML, CL	A–4, A–6, A–7
Saline land part.				
Havrelon:				
Hn	0–6	Very fine sandy loam	SM, ML	A–2, A–4
	6–60	Stratified silty clay to fine sandy loam	ML, CL	A–4, A–6, A–7
Ho	0–8	Silty clay loam	CL	A–4, A–6, A–7
	8–60	Stratified silty clay to fine sandy loam	ML, CL	A–4, A–6, A–7
Heil:				
Hs	0–2	Silty clay loam	CL	A–6, A–7
	2–60	Silty clay, clay	CH	A–7
Krem:				
KrB	0–28	Loamy fine sand	SM	A–2
	28–34	Clay loam	CL	A–6, A–7
	34–60	Loam, clay loam	ML, CL	A–4, A–6, A–7
Lallie:				
La	0–3	Silty clay loam, silty clay, clay	CL, CH	A–6, A–7
	3–42	Clay, silty clay	CL, CH	A–7
	42–60	Loamy fine sand, loam	SM, ML, CL	A–2, A–4
Lihen:				
LeB, LeC	0–60	Loamy fine sand	SM	A–2, A–4
[1] LgE:				
Lihen part	0–60	Loamy fine sand	SM	A–2, A–4
Zahl part	0–6	Loam	ML	A–4
	6–60	Clay loam, loam	CL	A–4, A–6
Linton:				
[1] LmB:				
Linton part	0–60	Silt loam	ML	A–4
Mandan part	0–60	Silt loam	ML	A–4

and classifications—Continued

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0 0 0	100 100 95–100	100 100 95–100	60–85 60–80 60–80	35–50 5–30 5–20	<20 --- ---	NP–10 NP NP
0 0 0	100 100 100	100 100 100	95–100 95–100 85–100	85–95 90–95 60–95	20–45 40–50 20–50	10–30 20–30 5–30
0 0 0	100 100 100	100 100 100	95–100 95–100 90–100	80–95 80–95 75–95	50–75 50–75 40–75	25–50 25–50 20–50
0 0	100 100	100 100	90–100 90–100	70–90 70–95	20–45 20–45	5–25 5–25
0–5 0–5 0–5	95–100 95–100 95–100	90–100 90–100 90–100	80–95 80–95 80–95	60–90 60–75 60–75	25–40 25–45 25–45	3–18 5–25 5–25
0 0 0	100 100 100	100 100 100	85–95 90–100 85–95	55–70 70–95 55–80	15–35 30–70 20–45	NP–10 10–50 5–25
0 0	100 100	100 100	70–95 85–100	40–65 60–80	<35 25–45	NP–10 5–25
0 0	100 100	100 100	85–100 85–100	60–95 60–80	30–45 25–45	10–25 5–25
0 0	100 100	100 100	90–100 90–100	70–95 75–95	35–50 50–70	15–30 25–45
0–1 0–5 0–5	95–100 95–100 95–100	95–100 95–100 95–100	50–75 85–95 85–95	15–30 60–80 60–80	--- 35–50 25–45	NP 15–30 4–24
0 0 0	100 100 100	100 100 100	95–100 95–100 85–95	85–95 85–95 45–75	25–70 40–70 10–30	11–45 20–50 NP–10
0	100	100	50–85	15–50	<25	NP–5
0	100	100	50–85	15–50	<25	NP–5
0–1 0–1	95–100 95–100	95–100 95–100	80–95 80–95	55–75 60–80	25–40 25–40	NP–10 10–25
0	100	100	90–100	70–90	20–40	NP–10
0	100	100	90–100	70–90	20–40	NP–10

TABLE 11.—*Engineering properties*

Soil and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
[1] LmC:				
Linton part	0-60	Silt loam	ML	A-4
Mandan part	0-60	Silt loam	ML	A-4
[1] LmD:				
Linton part	0-60	Silt loam	ML	A-4
Mandan part	0-60	Silt loam	ML	A-4
[1] LmE:				
Linton part	0-60	Silt loam	ML	A-4
Mandan part	0-60	Silt loam	ML	A-4
Lohler:				
Lw	0-22	Silty clay loam	CL, ML	A-6, A-7
	22-60	Silty clay, silty clay loam	CH, CL	A-7
Ly	0-8	Silty clay	CH, CL	A-7
	8-60	Silty clay, silty clay loam	CH, CL	A-7
Makoti:				
Ma	0-6	Silty clay loam	CL	A-6, A-7
	6-34	Silt loam, silty clay loam	ML, CL	A-4, A-6, A-7
	34-60	Stratified very fine sandy loam to silty clay loam.	ML, CL	A-4, A-6, A-7
Mandan:				
MaA, MdB, MdC	0-60	Silt loam	ML	A-4
Marysland:				
Mf	0-4	Loam	CL	A-6, A-7
	4-26	Loam, clay loam, sandy clay loam	CL, SC	A-6
	26-60	Sand, fine sand, coarse sand	SP-SM, SM	A-1, A-2, A-3
Max:				
MgB	0-17	Loam	ML, CL	A-4, A-6, A-7
	17-60	Loam, clay loam	ML, CL	A-4, A-6, A-7
[1] MhC:				
Max part	0-17	Loam	ML, CL	A-4, A-6, A-7
	17-60	Loam, clay loam	ML, CL	A-4, A-6, A-7
Bowbells part	0-9	Loam	CL, ML	A-4, A-6
	9-25	Loam, clay loam	CL	A-6, A-7
	25-60	Loam, clay loam	CL	A-6, A-7
Zahl part	0-6	Loam	ML	A-4
	6-60	Clay loam, loam	ML, CL	A-4, A-6
[1] MlC:				
Max part	0-17	Loam	ML, CL	A-4, A-6, A-7
	17-60	Loam, clay loam	ML, CL	A-4, A-6, A-7
Zahl part	0-6	Loam	ML	A-4
	6-60	Clay loam, loam	ML, CL	A-4, A-6
[1] MlD:				
Max part	0-17	Loam	ML, CL	A-4, A-6, A-7
	17-60	Loam, clay loam	ML, CL	A-4, A-6, A-7
Zahl part	0-6	Loam	ML	A-4
	6-60	Clay loam, loam	ML, CL	A-4, A-6
Morton:				
MoC	0-7	Loam	ML, CL	A-4, A-6
	7-18	Silty clay loam	CL	A-6, A-7
	18-38	Loam, silt loam, silty clay loam	ML, CL	A-4, A-6, A-7
	38-60	Weathered bedrock.		

and classifications—Continued

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	100	90–100	70–90	20–40	NP–10
0	100	100	90–100	70–90	20–40	NP–10
0	100	100	90–100	70–90	20–40	NP–10
0	100	100	90–100	70–90	20–40	NP–10
0	100	100	90–100	70–90	20–40	NP–10
0	100	100	90–100	70–90	20–40	NP–10
0	100	100	90–100	80–95	30–50	10–30
0	100	100	95–100	80–95	45–70	25–50
0	100	100	95–100	80–95	45–70	25–50
0	100	100	95–100	80–95	45–70	25–50
0	100	100	95–100	85–95	30–45	15–30
0	100	100	90–100	70–95	25–45	5–25
0	100	100	85–100	60–95	20–45	5–30
0	100	100	90–100	70–90	20–40	NP–10
0	95–100	95–100	85–95	50–80	25–45	10–20
0	90–100	85–100	80–95	45–80	25–40	10–20
0	70–95	50–90	35–70	5–20	---	NP
0–3	100	95–100	85–95	60–75	25–45	5–25
0–3	100	95–100	85–100	60–80	25–45	5–25
0–3	100	95–100	85–95	60–75	25–45	5–25
0–3	100	95–100	85–100	60–80	25–45	5–25
0–5	95–100	90–100	85–95	60–90	20–40	5–25
0–5	95–100	90–100	80–95	60–80	20–45	10–25
0–5	95–100	90–100	80–95	60–80	20–45	10–25
0–1	95–100	95–100	80–95	55–75	25–40	NP–10
0–1	95–100	95–100	80–95	60–80	25–40	10–25
0–3	100	95–100	85–95	60–75	25–45	5–25
0–3	100	95–100	85–100	60–80	25–45	5–25
0–1	95–100	95–100	80–95	55–75	25–40	NP–10
0–1	95–100	95–100	80–95	60–80	25–40	10–25
0–3	100	95–100	85–95	60–75	25–45	5–25
0–3	100	95–100	85–100	60–80	25–45	5–25
0–1	95–100	95–100	80–95	55–75	25–40	NP–10
0–1	95–100	95–100	80–95	60–80	25–40	10–25
0	100	100	85–100	60–90	25–40	5–20
0	100	100	95–100	85–95	25–50	10–30
0	100	100	95–100	75–95	25–50	5–30

TABLE 11.—*Engineering properties*

Soil and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Niobell:				
[1] NbA:				
Niobell part	0–11	Loam	ML, CL	A–4, A–6
	11–60	Clay loam	CL, CH	A–6, A–7
Williams part	0–5	Loam	CL, ML	A–4, A–6, A–7
	5–16	Clay loam, loam	CL	A–6, A–7
	16–60	Clay loam, loam	CL	A–6, A–7
[1] NbB:				
Niobell part	0–11	Loam	ML, CL	A–4, A–6
	11–60	Clay loam	CL, CH	A–6, A–7
Williams part	0–5	Loam	CL, ML	A–4, A–6, A–7
	5–16	Clay loam, loam	CL	A–6, A–7
	16–60	Clay loam, loam	CL	A–6, A–7
Noonan:				
[1] NmB:				
Noonan part	0–8	Loam	ML, CL	A–4, A–6
	8–22	Clay loam	CL, CH	A–6, A–7
	22–60	Loam, clay loam	ML, CL	A–4, A–6
Miranda part	0–4	Loam	CL–ML, CL	A–4, A–6
	4–60	Loam, clay loam	CL	A–6
[1] NmD:				
Noonan part	0–8	Loam	ML, CL	A–4, A–6
	8–22	Clay loam	CL, CH	A–6, A–7
	22–60	Loam, clay loam	ML, CL	A–4, A–6
Miranda part	0–4	Loam	CL–ML, CL	A–4, A–6
	4–60	Loam, clay loam	CL	A–6
Nutley:				
NtA, NtB	0–8	Silty clay	CH	A–7
	8–60	Clay, silty clay	CH	A–7
Orthents:				
Or.				
Parnell:				
Pa, Pe	0–8	Silty clay loam	OL, OH, CL, CH	A–7
	8–38	Clay loam, silty clay loam, silty clay	CL, CH	A–7
	38–60	Clay loam, silty clay loam, silty clay	CL, CH	A–6, A–7
Parshall:				
PhA, PhB, PhC, PhD	0–27	Fine sandy loam	SM, ML	A–4, A–2
	27–60	Fine sandy loam, sandy loam, loamy sand	SM, ML	A–4, A–2
PoA, PoB	0–15	Loam	ML	A–4
	15–60	Fine sandy loam, sandy loam, loamy sand	SM, ML	A–4, A–2
Regent:				
RgC	0–35	Silty clay loam, silty clay	CL, CH	A–6, A–7
	35–60	Weathered bedrock.		
Rhoades:				
[1] RhB	0–3	Loam	ML	A–4
	3–60	Clay loam, silty clay, clay	CL, CH	A–7
Riverwash:				
Rm.				
Roseglen:				
Ro	0–22	Silt loam	CL–ML, CL	A–4, A–6
	22–60	Silt loam, loam	CL–ML, CL	A–4, A–6

and classifications—Continued

Fragments > 3 inches	Percentage passing sieve number— 4	10	40	200	Liquid limit	Plasticity index
Pct					*Pct*	
0	95–100	95–100	85–95	60–75	25–40	5–25
0–1	95–100	95–100	90–100	70–80	30–60	15–35
0–5	95–100	95–100	85–95	60–90	25–45	5–25
0–5	95–100	95–100	80–95	60–80	30–50	10–35
0–5	95–100	95–100	80–95	60–80	30–50	10–35
0	95–100	95–100	85–95	60–75	25–40	5–25
0–1	95–100	95–100	90–100	70–80	30–60	15–35
0–5	95–100	95–100	85–95	60–90	25–45	5–25
0–5	95–100	95–100	80–95	60–80	30–50	10–30
0–5	95–100	95–100	80–95	60–80	30–50	10–30
0–1	95–100	95–100	80–95	55–75	20–40	5–25
0–1	95–100	95–100	85–95	65–80	25–60	10–35
0–1	95–100	95–100	80–95	60–80	25–40	10–30
0	100	100	85–95	60–75	25–40	5–19
<5	95–100	95–100	85–95	60–80	25–40	15–30
0–1	95–100	95–100	80–95	55–75	20–40	5–25
0–1	95–100	95–100	85–95	65–80	25–60	10–35
0–1	95–100	95–100	80–95	60–80	25–40	10–30
0	100	100	85–95	60–75	25–40	5–19
<5	95–100	95–100	85–95	60–80	25–40	15–30
0	100	100	95–100	85–100	50–74	22–45
0	100	100	95–100	85–100	60–95	30–63
0	100	100	95–100	85–95	40–60	15–30
0	100	95–100	90–100	70–95	40–80	20–50
0	95–100	90–100	80–95	70–95	30–80	15–50
0	100	100	60–85	30–55	----------	NP
0	100	100	60–85	30–55	----------	NP
0	100	100	85–95	60–75	20–40	NP–10
0	100	100	60–85	30–55	----------	NP
0	100	100	90–100	85–95	35–70	15–45
0	100	100	75–90	45–65	25–35	NP–10
0	100	100	90–100	80–95	40–75	20–45
0	100	100	90–100	70–90	25–40	5–20
0	100	100	85–100	60–90	25–40	5–20

TABLE 11.—*Engineering properties*

Soil and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
[1] RpB:				
Roseglen part	0-22	Silt loam	CL-ML, CL	A-4, A-6
	22-60	Sitl loam, loam	CL-ML, CL	A-4, A-6
Tansem part	0-32	Loam	CL-ML, CL	A-4, A-6
	32-60	Stratified very fine sand to silt loam	ML	A-4
[1] RpC:				
Roseglen part	0-22	Silt loam	CL-ML, CL	A-4, A-6
	22-60	Silt loam, loam	CL-ML, CL	A-4, A-6
Tansem part	0-32	Loam	CL-ML, CL	A-4, A-6
	32-60	Stratified very fine sand to silt loam	ML	A-4
Ruso:				
RsA	0-14	Coarse sandy loam	SM	A-2, A-4
	14-22	Coarse sandy loam	SM	A-2, A-4
	22-60	Gravelly loamy coarse sand, gravelly coarse sand.	SP-SM	A-1
[1] RtB:				
Ruso part	0-14	Coarse sandy loam	SM	A-2, A-4
	14-22	Coarse sandy loam	SM	A-2, A-4
	22-60	Gravelly loamy coarse sand, gravelly coarse sand.	SP-SM	A-1
Manning part	0-6	Coarse sandy loam	SM	A-2, A-4
	6-21	Coarse sandy loam, fine sandy loam, loam.	SM, ML, CL, SC	A-2, A-4, A-6
	21-60	Gravelly loamy coarse sand	GM, SM	A-1, A-2
[1] RtC:				
Ruso part	0-14	Coarse sandy loam	SM	A-2, A-4
	14-22	Coarse sandy loam	SM	A-2, A-4
	22-60	Gravelly loamy coarse sand, gravelly coarse sand.	SP-SM	A-1
Manning part	0-6	Coarse sandy loam	SM	A-2, A-4
	6-21	Sandy loam, fine sandy loam, loam	SM, ML, CL	A-2, A-4, A-6
	21-60	Gravelly loamy coarse sand	GM, SM	A-1, A-2
[1] RxB:				
Ruso part	0-14	Coarse sandy loam	SM	A-2, A-4
	14-22	Coarse sandy loam	SM	A-2, A-4
	22-60	Gravelly loamy coarse sand, gravelly coarse sand.	SP-SM	A-1
Manning part	0-5	Coarse sandy loam	SM	A-2, A-4
	5-21	Sandy loam, fine sandy loam, loam	SM, ML, CL	A-2, A-4, A-6
	21-60	Gravelly loamy coarse sand	GM, SM	A-1, A-2
[1] RyC:				
Ruso part	0-14	Coarse sandy loam	SM	A-2, A-4
	14-22	Coarse sandy loam	SM	A-2, A-4
	22-60	Gravelly loamy coarse sand, gravelly coarse sand.	SP-SM	A-1
Wabek part	0-7	Loam	ML	A-4
	7-60	Very gravelly coarse sand, gravelly loamy coarse sand, sand.	SM, SP, GM, GP	A-1, A-2
RzA	0-14	Coarse sandy loam	SM	A-2, A-4
	14-22	Coarse sandy loam	SM	A-2, A-4
	22-60	Gravelly loamy coarse sand, gravelly coarse sand.	SP-SM	A-1
Seroco:				
SeD	0-60	Fine sand	SM	A-2

and classifications—Continued

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0 0	100 100	100 100	90–100 85–100	70–90 60–90	25–40 25–40	5–20 5–20
0 0	100 100	100 100	85–95 90–100	60–75 70–90	25–40 20–40	5–20 NP–10
0 0	100 100	100 100	90–100 85–100	70–90 60–90	25–40 25–40	5–20 5–20
0 0	100 100	100 100	85–95 90–100	60–75 70–90	20–40 20–40	5–25 NP–10
0–1 0–1 0–3	95–100 85–100 50–100	95–100 85–100 50–95	60–70 60–70 10–30	30–40 30–40 5–15		NP NP NP
0–1 0–1 0–3	95–100 85–100 50–100	95–100 85–100 50–95	60–70 60–70 10–30	30–40 30–40 5–15		NP NP NP
0 0–3	95–100 85–100	95–100 80–100	60–85 60–95	30–50 30–70	 <35	NP NP–15
0–5	25–75	15–65	10–40	5–25		NP
0–1 0–1 0–3	95–100 85–100 50–100	95–100 85–100 50–95	60–70 60–70 10–30	30–40 30–40 5–15		NP NP NP
0 0–3 0–5	95–100 85–100 25–75	95–100 80–100 15–65	60–85 60–95 10–40	30–50 30–70 5–25	 <35 	NP NP–15 NP
0–1 0–1 0–3	95–100 85–100 50–100	95–100 85–100 50–95	60–70 60–70 10–30	30–40 30–40 5–15		NP NP NP
0 0–3 0–5	95–100 85–100 25–75	95–100 80–100 15–65	60–85 60–95 10–40	30–50 30–70 5–25	 <35 	NP NP–15 NP
0–1 0–1 0–3	95–100 85–100 50–100	95–100 85–100 50–95	60–70 60–70 10–30	30–40 30–40 5–15		NP NP NP
0–1 0–1	90–100 50–100	90–100 50–95	75–90 10–30	50–70 2–15	25–40 	NP–10 NP
0–1 0–1 0–3	95–100 85–100 50–100	95–100 85–100 50–95	60–70 60–70 10–30	30–40 30–40 5–15		NP NP NP
0	100	100	65–80	20–35		NP

TABLE 11.—*Engineering properties*

Soil and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Sinai:				
Sn	0–21	Silty clay	CL, CH, MH	A–7
	21–37	Silty clay, silty clay loam, clay	CL, CH, MH	A–7
	37–60	Stratified silty clay to silt loam	CL, CH	A–6, A–7
Straw:				
St	0–60	Loam	CL	A–4, A–6
Straw:				
[1] Sx	0–60	Loam	CL	A–4, A–6
Telfer:				
[1] TlC:				
Telfer part	0–15	Loamy fine sand	SM	A–2
	15–60	Fine sand, loamy fine sand	SM	A–2
Lihen part	0–60	Loamy fine sand	SM	A–2, A–4
Tonka:				
[1] Tp:				
Tonka part	0–11	Silt loam	CL–ML, CL	A–4, A–6
	11–17	Silty clay, clay loam, clay	CH, CL	A–6, A–7
	17–60	Silty clay loam, clay loam	CL	A–6, A–7
Parnell part	0–8	Silty clay loam	CL, CH	A–7
	8–38	Clay loam, silty clay loam, silty clay	CL, CH	A–7
	38–60	Clay loam, silty clay loam, silty clay	CL, CH	A–6, A–7
Trembles:				
Tr	0–60	Fine sandy loam	SM, ML	A–4, A–2
Vebar:				
[1] VwC:				
Vebar part	0–38	Fine sandy loam	SM, ML	A–4, A–2
	38–60	Weathered bedrock.		
Williams part	0–5	Fine sandy loam	SM, ML	A–4
	5–16	Clay loam, loam	CL	A–6, A–7
	16–60	Clay loam, loam	CL	A–6, A–7
Wabek:				
[1] WaB:				
Wabek part	0–7	Loam	ML	A–4
	7–60	Very gravelly coarse sand, gravelly loamy coarse sand, sand.	SM, SP, GM, GP	A–1, A–2
Max part	0–17	Loam	ML, CL	A–4, A–6, A–7
	17–60	Loam, clay loam	ML, CL	A–4, A–6, A–7
Zahl part	0–6	Loam	ML	A–4
	6–60	Clay loam, loam	ML, CL	A–4, A–6
[1] WaD:				
Wabek part	0–7	Loam	ML	A–4
	7–60	Very gravelly coarse sand, gravelly loamy coarse sand, sand.	SM, SP, GM, GP	A–1, A–2
Max part	0–17	Loam	ML, CL	A–4, A–6, A–7
	17–60	Loam, clay loam	ML, CL	A–4, A–6, A–7
Zahl part	0–6	Loam	ML	A–4
	6–60	Clay loam, loam	ML, CL	A–4, A–6
[1] WbB, [1] WbD	0–7	Loam, gravelly loam	ML	A–4
	7–60	Very gravelly coarse sand, gravelly loamy coarse sand, sand.	SM, SP, GM, GP	A–1, A–2

and classifications—Continued

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	90–100	85–100	80–100	45–70	20–45
0	100	90–100	85–100	80–100	45–70	20–45
0	100	90–100	85–100	70–95	35–70	15–45
0	100	100	85–100	60–90	25–40	10–20
0	100	100	85–100	60–90	25–40	10–20
0	100	100	50–80	15–35	----------------	NP
0	100	100	50–80	15–35	----------------	NP
0	100	100	50–85	15–50	<25	NP–5
0–2	100	95–100	90–100	70–90	20–40	5–25
0–2	100	95–100	90–100	75–95	35–55	15–35
0–3	100	95–100	90–100	70–90	20–50	10–30
0	100	100	95–100	85–95	40–60	15–30
0	100	95–100	90–100	70–95	40–80	20–50
0	95–100	90–100	80–95	70–95	30–80	15–50
0	100	100	60–85	30–55	<25	NP–5
0	100	100	60–85	30–55	----------------	NP
0	100	100	70–85	40–55	----------------	NP
0–5	95–100	95–100	80–95	60–80	30–50	10–30
0–5	95–100	95–100	80–95	60–80	30–50	10–30
0–1	90–100	90–100	75–90	50–70	25–40	NP–10
0–1	50–100	50–95	10–30	2–15	----------------	NP
0–3	100	95–100	85–95	60–75	25–45	5–25
0–3	100	95–100	85–100	60–80	25–45	5–25
0–1	95–100	95–100	80–95	55–75	25–40	NP–10
0–1	95–100	95–100	80–95	60–80	25–40	10–25
0–1	90–100	90–100	75–90	50–70	25–40	NP–10
0–1	50–100	50–95	10–30	2–15	----------------	NP
0–3	100	95–100	85–95	60–75	25–45	5–25
0–3	100	95–100	85–100	60–80	25–45	5–25
0–1	95–100	95–100	80–95	55–75	25–40	NP–10
0–1	95–100	95–100	80–95	60–80	25–40	10–25
0–1	90–100	90–100	75–90	50–70	25–40	NP–10
0–1	50–100	50–95	10–30	2–15	----------------	NP

TABLE 11.—*Engineering properties*

Soil and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
Williams:				
WlB	0–5	Stony loam	CL, ML	A-4, A-6, A-7
	5–16	Clay loam, loam	CL	A-6, A-7
	16–60	Clay loam, loam	CL	A-6, A-7
WmA, WmB	0–5	Clay loam	CL, ML	A-4, A-6, A-7
	5–16	Clay loam, loam	CL	A-6, A-7
	16–60	Clay loam, loam	CL	A-6, A-7
[1] WoA:				
Williams part	0–5	Loam	CL, ML	A-4, A-6, A-7
	5–16	Clay loam, loam	CL	A-6, A-7
	16–60	Clay loam, loam	CL	A-6, A-7
Bowbells part	0–9	Loam	CL, ML	A-4, A-6
	9–25	Loam, clay loam	CL	A-6, A-7
	25–60	Loam, clay loam	CL	A-6, A-7
[1] WoB:				
Williams part	0–5	Loam	CL, ML	A-4, A-6, A-7
	5–16	Clay loam, loam	CL	A-6, A-7
	16–60	Clay loam, loam	CL	A-6, A-7
Bowbells part	0–9	Loam	CL, ML	A-4, A-6
	9–25	Loam, clay loam	CL	A-6, A-7
	25–60	Loam, clay loam	CL	A-6, A-7
[1] WoC:				
Williams part	0–5	Loam	CL, ML	A-4, A-6, A-7
	5–16	Clay loam, loam	CL	A-6, A-7
	16–60	Clay loam, loam	CL	A-6, A-7
Bowbells part	0–9	Loam	CL, ML	A-4, A-6
	9–25	Loam, clay loam	CL	A-6, A-7
	25–60	Loam, clay loam	CL	A-6, A-7
Williams:				
[1] WpB:				
Williams part	0–5	Loam	CL, ML	A-4, A-6, A-7
	5–16	Clay loam, loam	CL	A-6, A-7
	16–60	Clay loam, loam	CL	A-6, A-7
Bowbells part	0–9	Loam	CL, ML	A-4, A-6
	9–25	Loam, clay loam	CL	A-6, A-7
	25–60	Loam, clay loam	CL	A-6, A-7
Zahl part	0–6	Loam	ML	A-4
	6–60	Clay loam, loam	ML, CL	A-4, A-6
[1] WrB:				
Williams part	0–5	Loam	CL, ML	A-4, A-6
	5–16	Clay loam, loam	CL	A-6, A-7
	16–60	Clay loam, loam	CL	A-6, A-7
Mine sink part.				
Wilton:				
WsA	0–27	Silt loam	ML, CL	A-4
	27–60	Loam, clay loam	ML, CL	A-4, A-6, A-7
[1] WtB:				
Wilton part	0–27	Silt loam	ML, CL	A-4
	27–60	Loam, clay loam	ML, CL	A-4, A-6, A-7
Temvik part	0–26	Silt loam	ML	A-4
	26–60	Clay loam, loam	ML, CL	A-4, A-6

and classifications—Continued

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
1-15	95-100	95-100	85-95	60-90	25-45	5-25
0-5	95-100	95-100	80-95	60-80	30-50	10-30
0-5	95-100	95-100	80-95	60-80	30-50	10-30
0-5	95-100	95-100	85-95	60-90	25-45	5-25
0-5	95-100	95-100	80-95	60-80	30-50	10-30
0-5	95-100	95-100	80-95	60-80	30-50	10-30
0-5	95-100	95-100	85-95	60-90	25-45	5-25
0-5	95-100	95-100	80-95	60-80	30-50	10-30
0-5	95-100	95-100	80-95	60-80	30-50	10-30
0-5	95-100	90-100	85-95	60-90	20-40	5-25
0-5	95-100	90-100	80-95	60-80	20-45	10-25
0-5	95-100	90-100	80-95	60-80	20-45	10-25
0-5	95-100	95-100	85-95	60-90	25-45	5-25
0-5	95-100	95-100	80-95	60-80	30-50	10-30
0-5	95-100	95-100	80-95	60-80	30-50	10-30
0-5	95-100	90-100	85-95	60-90	20-40	5-25
0-5	95-100	90-100	80-95	60-80	20-45	10-25
0-5	95-100	90-100	80-95	60-80	20-45	10-25
0-5	95-100	95-100	85-95	60-90	25-45	5-25
0-5	95-100	95-100	80-95	60-80	30-50	10-30
0-5	95-100	95-100	80-95	60-80	30-50	10-30
0-5	95-100	90-100	85-95	60-90	20-40	5-25
0-5	95-100	90-100	80-95	60-80	20-45	10-25
0-5	95-100	90-100	80-95	60-80	20-45	10-25
0-5	95-100	95-100	85-95	60-90	25-45	5-25
0-5	95-100	95-100	80-95	60-80	30-50	10-30
0-5	95-100	95-100	80-95	60-80	30-50	10-30
0-5	95-100	90-100	85-95	60-90	20-40	5-25
0-5	95-100	90-100	80-95	60-80	20-45	10-25
0-5	95-100	90-100	80-95	60-80	20-45	10-25
0-1	95-100	95-100	80-95	55-75	25-40	NP-10
0-1	95-100	95-100	80-95	60-80	25-40	10-25
0-5	95-100	95-100	85-95	60-90	25-45	5-25
0-5	95-100	95-100	80-95	60-80	30-50	10-30
0-5	95-100	95-100	80-95	60-80	30-50	10-30
0	100	100	90-100	70-90	25-40	NP-10
0-5	90-100	85-100	80-95	60-80	25-50	5-25
0	100	100	90-100	70-90	25-40	NP-10
0-5	90-100	85-100	80-95	60-80	25-50	5-25
0	100	100	90-100	70-90	25-40	NP-10
0-1	95-100	95-100	80-95	60-80	25-40	10-25

TABLE 11.—*Engineering properties*

Soil and map symbol	Depth	USDA texture	Classification	
			Unified	AASHTO
	In			
[1] WwC:				
Wilton part	0–27	Silt loam	ML, CL	A–4
	27–60	Loam, clay loam	ML, CL	A–4, A–6, A–7
Williams part	0–5	Silt loam	CL, ML	A–4, A–6, A–7
	5–16	Clay loam, loam	CL	A–6, A–7
	16–60	Clay loam, loam	CL	A–6, A–7
Zahl:				
[1] ZcE:				
Zahl part	0–6	Loam	ML	A–4
	6–60	Clay loam, loam	ML, CL	A–4, A–6
Cabba part	0–17	Loam	CL, ML	A–4, A–6
	17–60	Weathered bedrock.		
[1] ZmE:				
Zahl part	0–6	Loam	ML	A–4
	6–60	Clay loam, loam	ML, CL	A–4, A–6
Max part	0–17	Loam	ML, CL	A–4, A–6, A–7
	17–60	Loam, clay loam	ML, CL	A–4, A–6, A–7
[1] ZpE:				
Zahl part	0–6	Loam	ML	A–4
	6–60	Clay loam, loam	ML, CL	A–4, A–6
Max part	0–17	Loam	ML, CL	A–4, A–6, A–7
	17–60	Loam, clay loam	ML, CL	A–4, A–6, A–7
Parnell part	0–8	Silty clay loam	CL, CH	A–7
	8–38	Clay loam, silty clay loam, silty clay	CL, CH	A–7
	38–60	Clay loam, silty clay loam, silty clay	CL, CH	A–6, A–7
[1] ZwC:				
Zahl part	0–6	Loam	ML	A–4
	6–60	Clay loam, loam	ML, CL	A–4, A–6
Williams part	0–5	Loam	CL, ML	A–4, A–6, A–7
	5–16	Clay loam, loam	CL	A–6, A–7
	16–60	Clay loam, loam	CL	A–6, A–7

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and

and classifications for the major horizons of each soil in the survey area. These estimates are presented as ranges in values most likely to exist in areas where the soil is mapped.

Most soils have, within the upper 5 or 6 feet, horizons of contrasting properties. Information is presented for each of these contrasting horizons. *Depth* to the upper and lower boundaries of each horizon in a typical profile of each soil is indicated. More information about the range in depth and in properties of each horizon is given for each soil series in "Descriptions of the Soils."

Texture is described in table 11 in standard terms used by the United States Department of Agriculture. These terms are defined according to percentages of sand, silt, and clay in soil material that is less than 2 millimeters in diameter. "Loam," for example, is soil material that is 7 to 27 percent clay, 28 to 50 percent silt, and less than 52 percent sand. If a soil contains gravel or other particles coarser than sand, an appropriate modifier is added, for example, "gravelly loam." Other texture terms used by USDA are defined in the Glossary.

The two systems commonly used in classifying for engineering use are the Unified soil classification system (USCS) (*2*) and the American Association of State Highway and Transportation Officials soil classification system (AASHTO) (*1*). In table 11 soils in the survey area are classified according to both systems.

The USCS system classifies soils according to properties that affect their use as construction material. Soils are classified according to grain-size distribution of the fraction less than 3 inches in diameter, plasticity index, liquid limit, and organic matter content. Soils are grouped into 15 classes—eight classes of coarse-grained soils, identified as GW, GP, GM, GC, SW, SP, SM, and SC; six classes of fine-grained soils, identified as ML, CL, OL, MH, CH, and OH; and one class of highly organic soils, identified as Pt. Soils on the borderline between two classes have a dual classification symbol, for example CL–ML.

The AASHTO system classifies soils according to

and classifications—Continued

Fragments > 3 inches	Percentage passing sieve number—				Liquid limit	Plasticity index
	4	10	40	200		
Pct					*Pct*	
0	100	100	90–100	70–90	25–40	NP–10
0–5	90–100	85–100	80–95	60–80	25–50	5–25
0–5	95–100	95–100	85–95	60–90	25–45	5–25
0–5	95–100	95–100	80–95	60–80	30–50	10–30
0–5	95–100	95–100	80–95	60–80	30–50	10–30
0–1	95–100	95–100	80–95	55–75	25–40	NP–10
0–1	95–100	95–100	80–95	60–80	25–40	10–25
0–5	95–100	85–100	75–90	60–80	20–40	5–15
0–1	95–100	95–100	80–95	55–75	25–40	NP–10
0–1	95–100	95–100	80–95	60–80	25–40	10–25
0–3	100	95–100	85–95	60–75	25–45	5–25
0–3	100	95–100	85–100	60–80	25–45	5–25
0–1	95–100	95–100	80–95	55–75	25–40	NP–10
0–1	95–100	95–100	80–95	60–80	25–40	10–25
0–3	100	95–100	85–95	60–75	25–45	5–25
0–3	100	95–100	85–100	60–80	25–45	5–25
0	100	100	95–100	85–95	40–60	15–30
0	100	95–100	90–100	70–95	40–80	20–50
0	95–100	90–100	80–95	70–95	30–80	15–50
0–1	95–100	95–100	80–95	55–75	25–40	NP–10
0–1	95–100	95–100	80–95	60–80	25–40	10–25
0–5	95–100	95–100	85–95	60–90	25–45	5–25
0–5	95–100	95–100	80–95	60–80	30–50	10–30
0–5	95–100	95–100	80–95	60–80	30–50	10–30

behavior characteristics of the mapping unit.

those properties that affect their use in highway construction and maintenance. In this system a mineral soil is classified as one of seven basic groups ranging from A–1 through A–7 on the basis of grain-size distribution, liquid limit, and plasticity index. Soils in group A–1 are coarse grained and low in content of fines. At the other extreme, in group A–7, are fine-grained soils. Highly organic soils are classified as A–8 on the basis of visual inspection.

When laboratory data are available, the A–1, A–2, and A–7 groups are further classified as follows: A–1–a, A–1–b, A–2–4, A–2–5, A–2–6, A–2–7, A–7–5, and A–7–6. As an additional refinement, the desirability of soils as subgrade material can be indicated by a group index number. These numbers range from 0 for the best subgrade material to 20 or more for the poorest. The estimated classification, without group index numbers, is given in table 11. Also in table 11 the percentage, by weight, of cobbles or the rock fragments more than 3 inches in diameter are estimated for each major horizon. These estimates are determined largely by observing volume percentage in the field and then converting it, by formula, to weight percentage.

Percentage of the soil material less than 3 inches in diameter that passes each of four standard sieves is estimated for each major horizon. The estimates are based on tests of soils that were sampled in the survey area and in nearby areas and on field estimates from many borings made during the survey.

Liquid limit and plasticity index indicate the effect of water on the strength and consistency of soil. These indexes are used in both the USCS and the AASHTO soil classification systems. They are also used as indicators in making general predictions of soil behavior. Ranges in liquid limit and plasticity index are estimated on the basis of test data from the survey area or from nearby areas and on observations of the many soil borings made during the survey.

Physical and chemical properties

Table 12 shows estimated values for several soil characteristics and features that affect behavior of

TABLE 12.—*Physical and*

[The symbol < means less than; > means greater than.

Soil and map symbol	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
Aquents:				
Ac.				
Aquolls:				
Af.				
Arnegard:				
ArA, ArB, ArC	0–6	0.6–2.0	0.20–0.24	6.6–7.3
	6–60	0.6–2.0	0.14–0.18	6.6–8.4
Banks:				
Ba	0–4	0.6–6.0	0.06–0.09	6.6–7.8
	4–60	6.0–20	0.07–0.09	7.4–8.4
Bk	0–6	2.0–20	0.14–0.21	6.6–7.8
	6–60	6.0–20	0.07–0.09	7.4–8.4
Bowbells:				
BoA	0–9	0.6–2.0	0.17–0.24	6.6–7.3
	9–25	0.6–2.0	0.16–0.22	6.6–7.3
	25–60	0.2–0.6	0.14–0.18	7.9–8.4
[1] BsB:				
Bowbells part	0–9	0.6–2.0	0.17–0.24	6.6–7.3
	9–25	0.6–2.0	0.16–0.22	6.6–7.3
	25–60	0.2–0.6	0.14–0.18	7.9–8.4
Williams part	0–5	0.6–2.0	0.17–0.24	6.6–7.3
	5–16	0.6–2.0	0.16–0.20	6.6–7.8
	16–60	0.2–0.6	0.15–0.18	7.9–8.4
Bowdle:				
BwA	0–7	0.6–2.0	0.18–0.20	6.6–7.3
	7–32	0.6–2.0	0.19–0.22	6.6–7.3
	32–48	>20.0	0.03–0.06	7.4–7.8
[1] ByB:				
Bowdle part	0–7	0.6–2.0	0.18–0.20	6.6–7.3
	7–32	0.6–2.0	0.19–0.22	6.6–7.3
	32–60	>20.0	0.03–0.06	7.4–7.8
Stady part	0–9	0.6–2.0	0.20–0.22	6.6–7.3
	9–25	0.6–2.0	0.17–0.19	6.6–7.3
	25–60	>20.0	0.02–0.04	7.4–8.4
[1] ByC:				
Bowdle part	0–7	0.6–2.0	0.18–0.20	6.6–7.3
	7–32	0.6–2.0	0.19–0.22	6.6–7.3
	32–60	>20.0	0.03–0.06	7.4–7.8
Stady part	0–9	0.6–2.0	0.20–0.22	6.6–7.3
	9–25	0.6–2.0	0.17–0.19	6.6–7.3
	25–60	>20.0	0.02–0.04	7.4–8.4
Cabba:				
[1] CaE	0–17	0.6–2.0	0.15–0.19	6.6–7.8
	17–60			
[1] CbF:				
Cabba part	0–17	0.6–2.0	0.15–0.19	6.6–7.8
	17–60			
Shale outcrop part.				

chemical properties

Absence of an entry indicates that data were not estimated]

Salinity	Shrink-swell potential	Risk of corrosion		Wind erodibility group
		Uncoated steel	Concrete	
Mmhos/cm				
<2	Low	High	Low	6
<2	Low	High	Low	
<2	Low	Moderate	Low	2
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	5
<2	Low	Moderate	Low	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Low	Moderate	Low	6
<2	Moderate	Moderate	Low	
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	6
<2	Moderate	Moderate	Low	
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	6
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	6
<2	Moderate	Moderate	Low	
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	6
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	
<4	Moderate	High	Low	6
<4	Moderate	High	Low	6

TABLE 12.—*Physical and*

Soil and map symbol	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
Cohagen:				
[1] ChD:				
Cohagen part	0–18 18–60	2.0–6.0	0.13–0.18	7.4–8.4
Vebar part	0–38 38–60	2.0–6.0	0.15–0.17	6.1–7.8
[1] ChE:				
Cohagen part	0–18 18–60	2.0–6.0	0.13–0.18	7.4–8.4
Vebar part	0–38 38–60	2.0–6.0	0.15–0.17	6.1–7.8
Colvin:				
Co	0–60	0.2–2.0	0.16–0.22	7.4–9.0
Dimmick:				
Dm	0–60	<0.06	0.13–0.18	6.6–7.8
Divide:				
Dv	0–5 5–28 28–60	0.6–2.0 0.6–2.0 >20.0	0.18–0.22 0.16–0.19 0.03–0.07	7.9–8.4 7.9–8.4 7.9–8.4
Falkirk:				
FaA, FaB	0–28 28–34 34–60	0.6–2.0 0.6–2.0 0.2–0.6	0.20–0.22 0.13–0.17 0.14–0.16	6.6–7.3 7.4–7.8 7.4–8.4
[1] FbA:				
Falkirk part	0–28 28–34 34–60	0.6–2.0 0.6–2.0 0.2–0.6	0.20–0.22 0.13–0.17 0.14–0.16	6.6–7.3 7.4–7.8 7.4–8.4
Max part	0–17 17–60	0.6–2.0 0.2–0.6	0.20–0.22 0.14–0.19	6.6–7.8 7.9–8.4
[1] FbB:				
Falkirk part	0–28 28–34 34–60	0.6–2.0 0.6–2.0 0.2–0.6	0.20–0.22 0.13–0.17 0.14–0.16	6.6–7.3 7.4–7.8 7.4–8.4
Max part	0–17 17–60	0.6–2.0 0.2–0.6	0.20–0.22 0.14–0.19	6.6–7.8 7.9–8.4
[1] FbC:				
Falkirk part	0–28 28–34 34–60	0.6–2.0 0.6–2.0 0.2–0.6	0.20–0.22 0.13–0.17 0.14–0.16	6.6–7.3 7.4–7.8 7.4–8.4
Max part	0–17 17–60	0.6–2.0 0.2–0.6	0.20–0.22 0.14–0.19	6.6–7.8 7.9–8.4
Farnuf:				
FfA FfB	0–3 3–36 36–60	0.6–2.0 0.6–2.0 0.6–2.0	0.15–0.20 0.15–0.20 0.13–0.18	6.6–8.4 7.9–9.0 7.9–9.0
Flasher:				
FlD, FlE	0–9 9–17 17–60	2.0–6.0 6.0–20.0	0.13–0.17 0.08–0.12	7.4–7.8 7.4–7.8
Flaxton:				
FnA, FnB, FnC	0–10 10–31 31–60	2.0–6.0 2.0–6.0 0.2–0.6	0.16–0.18 0.08–0.12 0.15–0.17	6.6–7.3 6.6–7.3 6.6–7.3

chemical properties—Continued

Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Wind erodibility group
Mmhos/cm				
<2	Low	Moderate	Low	3
<2	Low	Moderate	Low	3
<2	Low	Moderate	Low	3
<2	Low	Moderate	Low	3
<2	Moderate	High	Low	4L
<2	High	High	Low	4
<2	Low	High	Low	4L
<2	Low	High	Low	
<2	Low	High	Low	
<2	Low	Moderate	Low	6
<2	Low	Moderate	Low	
<2	Moderate	Moderate	Low	
<2	Low	Moderate	Low	6
<2	Low	Moderate	Low	
<2	Moderate	Moderate	Low	
<2	Moderate	High	Low	6
<2	Moderate	High	Low	
<2	Low	Moderate	Low	6
<2	Low	Moderate	Low	
<2	Moderate	Moderate	Low	
<2	Moderate	High	Low	6
<2	Moderate	High	Low	
<2	Low	Moderate	Low	6
<2	Low	Moderate	Low	
<2	Moderate	Moderate	Low	
<2	Moderate	High	Low	6
<2	Moderate	High	Low	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Low	High	Low	
<2	Low	Moderate	Low	3
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	3
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	

TABLE 12.—*Physical and*

Soil and map symbol	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
Fossum:				
Fs	0–6	2.0–6.0	0.13–0.18	7.4–8.4
	6–18	6.0–20.0	0.06–0.11	7.4–8.4
	18–60	6.0–20.0	0.05–0.09	7.4–8.4
Grail:				
GaA, GaB	0–11	0.2–0.6	0.18–0.23	6.6–7.3
	11–20	0.2–0.6	0.14–0.17	6.6–7.3
	20–60	0.2–0.6	0.13–0.22	7.9–8.4
Grano:				
Gn	0–17	0.06–0.2	0.15–0.18	7.9–8.4
	17–48	0.06–0.2	0.14–0.17	7.9–8.4
	48–60	0.06–0.2	0.13–0.16	7.9–8.4
Grassna:				
GoA	0–17	0.6–2.0	0.22–0.24	6.6–7.3
	17–60	0.6–2.0	0.16–0.22	6.6–8.4
Hamerly:				
HaA	0–6	0.6–2.0	0.17–0.22	7.4–7.8
	6–35	0.6–2.0	0.15–0.19	7.4–7.8
	35–60	0.2–0.6	0.14–0.19	7.4–8.4
Harriet:				
[1] Hk:				
Harriet part	0–2	0.06–0.2	0.20–0.22	7.9–8.4
	2–11	0.06–0.2	0.15–0.23	8.5–9.0
	11–60	0.06–0.2	0.14–0.18	8.5–9.0
Saline land part.				
Havrelon:				
Hn	0–6	0.6–2.0	0.16–0.22	7.4–7.8
	6–60	0.6–2.0	0.15–0.19	7.4–7.8
Ho	0–8	0.6–2.0	0.20–0.24	7.4–7.8
	8–60	0.6–2.0	0.15–0.19	7.4–7.8
Heil:				
Hs	0–2	<0.06	0.15–0.24	6.6–7.3
	2–60	<0.06	0.13–0.18	7.4–9.0
Krem:				
KrB	0–28	6.0–20	0.09–0.12	6.6–7.3
	28–34	0.6–2.0	0.15–0.19	7.4–7.8
	34–60	0.2–0.6	0.15–0.19	7.9–8.4
Lallie:				
La	0–3	0.06–0.2	0.15–0.23	7.4–9.0
	3–60	0.06–0.2	0.13–0.23	7.4–9.0
Lihen:				
LeB, LeC	0–60	6.0–20	0.06–0.16	6.6–7.8
[1] LgE:				
Lihen part	0–60	6.0–20	0.06–0.16	6.6–7.8
Zahl part	0–6	0.6–2.0	0.20–0.22	7.4–7.8
	6–60	0.2–0.6	0.15–0.19	7.4–8.4
Linton:				
[1] LmB:				
Linton part	0–60	0.6–2.0	0.20–0.24	6.6–8.4
Mandan part	0–60	0.6–2.0	0.20–0.24	6.6–8.4
[1] LmC:				
Linton part	0–60	0.6–2.0	0.20–0.24	6.6–8.4

chemical properties—Continued

Salinity	Shrink-swell potential	Risk of corrosion		Wind erodibility group
		Uncoated steel	Concrete	
Mmhos/cm				
<2	Low	High	Low	3
<2	Low	High	Low	
<2	Low	High	Low	
<2	Moderate	High	Low	7
<2	High	High	Low	
<2	Moderate	High	Low	
<2	High	High	Low	4
<2	High	High	Low	
<2	High	High	Low	
<2	Moderate	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	4L
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Low	High	Moderate	6
4–12	High	High	Moderate	
4–12	Moderate	High	Moderate	
<2	Low	High	Low	4L
<2	Moderate	High	Low	
<2	Moderate	High	Low	4L
<2	Moderate	High	Low	
<2	Moderate	High	Moderate	7
4–12	High	High	Moderate	
<2	Low	Moderate	Low	2
<2	Moderate	High	Low	
<2	Moderate	High	Low	
1–10	High	High	Low	6
1–10	High	High	Low	
<2	Low	Moderate	Low	2
<2	Low	Moderate	Low	2
<2	Moderate	Moderate	Low	4L
<2	Moderate	Moderate	Low	
<2	Low	Moderate	Low	5
<2	Low	Moderate	Low	5
<2	Low	Moderate	Low	5

TABLE 12.—*Physical and*

Soil and map symbol	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
Mandan part	0–60	0.6–2.0	0.20–0.24	6.6–8.4
[1] LmD:				
Linton part	0–60	0.6–2.0	0.20–0.24	6.6–8.4
Mandan part	0–60	0.6–2.0	0.20–0.24	6.6–8.4
[1] LmE:				
Linton part	0–60	0.6–2.0	0.20–0.24	6.6–8.4
Mandan part	0–60	0.6–2.0	0.20–0.24	6.6–8.4
Lohler:				
Lw	0–22 22–60	0.2–0.6 0.06–0.6	0.18–0.24 0.13–0.17	7.4–7.8 7.4–7.8
Ly	0–8 8–60	0.06–0.6 0.06–0.6	0.15–0.18 0.13–0.17	7.4–7.8 7.4–7.8
Makoti:				
Ma	0–6 6–34 34–60	0.2–0.6 0.2–0.6 0.2–0.6	0.18–0.23 0.16–0.24 0.16–0.22	6.6–7.3 6.1–7.8 7.4–8.4
Mandan:				
MdA, MdB, MdC	0–60	0.6–2.0	0.20–0.24	6.6–8.4
Marysland:				
Mf	0–4 4–26 26–60	0.6–2.0 0.6–2.0 >6.0	0.17–0.22 0.15–0.19 0.02–0.07	7.9–8.4 7.9–8.4 7.9–8.4
Max:				
MgB	0–17 17–60	0.6–2.0 0.2–0.6	0.20–0.22 0.14–0.19	6.6–7.8 7.9–8.4
[1] MhC:				
Max part	0–17 17–60	0.6–2.0 0.2–0.6	0.20–0.22 0.14–0.19	6.6–7.8 7.9–8.4
Bowbells part	0–9 9–25 25–60	0.6–2.0 0.6–2.0 0.2–0.6	0.17–0.24 0.16–0.22 0.14–0.18	6.6–7.3 6.6–7.3 7.9–8.4
Zahl part	0–6 6–60	0.6–2.0 0.2–0.6	0.20–0.22 0.15–0.19	7.4–7.8 7.4–8.4
[1] MlC:				
Max part	0–17 17–60	0.6–2.0 0.2–0.6	0.20–0.22 0.14–0.19	6.6–7.8 7.9–8.4
Zahl part	0–6 6–60	0.6–2.0 0.2–0.6	0.20–0.22 0.15–0.19	7.4–7.8 7.4–8.4
[1] MlD:				
Max part	0–17 17–60	0.6–2.0 0.2–0.6	0.20–0.22 0.14–0.19	6.6–7.8 7.9–8.4
Zahl part	0–6 6–60	0.6–2.0 0.2–0.6	0.20–0.22 0.15–0.19	7.4–7.8 7.4–8.4
Morton:				
MoC	0–7 7–18 18–38 38–60	0.6–2.0 0.6–2.0 0.6–2.0	0.20–0.24 0.16–0.20 0.16–0.20	6.6–7.3 6.6–7.8 7.4–8.4

chemical properties—Continued

Salinity	Shrink-swell potential	Risk of corrosion		Wind erodibility group
		Uncoated steel	Concrete	
Mmhos/cm				
<2	Low	Moderate	Low	5
<2	Low	Moderate	Low	5
<2	Low	Moderate	Low	5
<2	Low	Moderate	Low	5
<2	Low	Moderate	Low	
<2	Moderate	High	Low	6
<2	High	High	Low	
<2	High	High	Low	4
<2	High	High	Low	
<2	Moderate	High	Low	7
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Low	Moderate	Low	5
<2	Moderate	High	Low	4L
<2	Moderate	High	Low	
<2	Low	High	Low	
<2	Moderate	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	6
<2	Moderate	High	Low	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Moderate	Moderate	Low	4L
<2	Moderate	Moderate	Low	
<2	Moderate	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	Moderate	Low	4L
<2	Moderate	Moderate	Low	
<2	Moderate	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	Moderate	Low	4L
<2	Moderate	Moderate	Low	
<2	Low	Moderate	Low	6
<2	Moderate	Moderate	Low	
<2	Moderate	Moderate	Low	

TABLE 12.—*Physical and*

Soil and map symbol	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
Niobell:				
[1] NbA:				
Niobell part	0–11 11–60	0.6–2.0 0.06–0.2	0.20–0.22 0.15–0.19	6.6–7.3 7.4–8.4
Williams part	0–5 5–16 16–60	0.6–2.0 0.6–2.0 0.2–0.6	0.17–0.24 0.16–0.20 0.15–0.18	6.6–7.3 6.6–7.8 7.9–8.4
[1] NbB:				
Niobell part	0–11 11–60	0.6–2.0 0.06–0.2	0.20–0.22 0.15–0.19	6.6–7.3 7.4–8.4
Williams part	0–5 5–16 16–60	0.6–2.0 0.6–2.0 0.2–0.6	0.17–0.24 0.16–0.20 0.15–0.18	6.6–7.3 6.6–7.8 7.9–8.4
Noonan:				
[1] NmB:				
Noonan part	0–8 8–22 22–60	0.6–2.0 0.06–0.2 0.06–0.2	0.20–0.22 0.12–0.14 0.10–0.14	6.6–7.3 7.4–9.0 7.9–9.0
Miranda part	0–4 4–60	0.6–2.0 <0.06	0.18–0.20 0.13–0.17	6.6–7.3 8.5–9.0
[1] NmD:				
Noonan part	0–8 8–22 22–60	0.6–2.0 0.06–0.2 0.06–0.2	0.20–0.22 0.12–0.14 0.10–0.14	6.6–7.3 7.4–9.0 7.9–9.0
Miranda part	0–4 4–60	0.6–2.0 <0.06	0.18–0.20 0.13–0.17	6.6–7.3 8.5–9.0
Nutley:				
NtA, NtB	0–8 8–60	0.06–0.2 0.06–0.2	0.10–0.14 0.08–0.12	7.4–8.4 7.4–8.4
Orthents:				
Or.				
Parnell:				
Pa, Pe	0–8 8–38 38–60	0.2–0.6 0.06–0.2 0.06–0.2	0.18–0.22 0.13–0.19 0.11–0.19	6.1–7.8 6.6–7.8 6.6–8.4
Parshall:				
PhA, PhB, PhC, PhD	0–27 27–60	2.0–6.0 2.0–6.0	0.16–0.18 0.12–0.17	6.6–7.3 6.6–8.4
PoA, PoB	0–15 15–60	0.6–2.0 2.0–6.0	0.20–0.22 0.12–0.17	6.6–8.4 6.6–8.4
Regent:				
RgC	0–35 35–60	0.06–0.2	0.17–0.20	6.6–8.4
Rhoades:				
[1] RhB	0–3 3–60	0.6–6.0 <0.2	0.13–0.15 0.10–0.12	6.1–7.3 7.4–9.0
Riverwash:				
Rm.				
Roseglen:				
Ro	0–22 22–60	0.6–2.0 0.6–2.0	0.22–0.24 0.20–0.22	6.6–7.3 6.6–7.8
[1] RpB:				
Roseglen part	0–22 22–60	0.6–2.0 0.6–2.0	0.22–0.24 0.17–0.22	6.6–7.3 6.6–7.8

chemical properties—Continued

Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Wind erodibility group
Mmhos/cm				
<2	Moderate	Moderate	Low	6
<2	High	High	Moderate	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Moderate	Moderate	Low	6
<2	High	High	Moderate	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Moderate	Moderate	Low	6
<2	High	High	Moderate	
2–8	Moderate	High	Moderate	
<2	Low	High	Moderate	8
<2	Moderate	High	Moderate	
<2	Moderate	Moderate	Low	6
<2	High	High	Moderate	
2–8	Moderate	High	Moderate	
<2	Low	High	Moderate	8
<2	Moderate	High	Moderate	
<2	High	High	Low	4
<2	High	High	Low	
<2	Moderate	High	Low	7
<2	High	High	Low	
<2	High	High	Low	
<2	Low	Moderate	Low	3
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	5
<2	Low	Moderate	Low	
0–8	High	High	Moderate	7
<2	Low	Moderate	Low	3
2–16	High	High	Low	
<2	Moderate	Moderate	Low	6
<2	Moderate	Moderate	Low	
<2	Moderate	Moderate	Low	6
<2	Moderate	Moderate	Low	

TABLE 12.—*Physical and*

Soil and map symbol	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
Tansem part	0–32 32–60	0.6–2.0 0.6–2.0	0.20–0.24 0.20–0.22	6.6–7.3 7.4–8.4
[1] RpC:				
Roseglen part	0–22 22–60	0.6–2.0 0.6–2.0	0.22–0.24 0.20–0.22	6.6–7.3 6.6–7.8
Tansem part	0–32 32–60	0.6–2.0 0.6–2.0	0.20–0.24 0.20–0.22	6.6–7.3 7.4–8.4
Ruso:				
RsA, RzA	0–14 14–22 22–60	2.0–6.0 2.0–6.0 >20.0	0.13–0.15 0.11–0.15 0.02–0.04	6.6–7.3 6.6–7.3 7.4–7.8
[1] RtB:				
Ruso part	0–14 14–22 22–60	2.0–6.0 2.0–6.0 >20.0	0.13–0.15 0.11–0.15 0.02–0.04	6.6–7.3 6.6–7.3 7.4–7.8
Manning part	0–6 6–21 21–60	2.0–6.0 2.0–6.0 >20.0	0.13–0.18 0.12–0.20 0.02–0.08	6.6–7.3 6.6–8.4 7.9–8.4
[1] RtC:				
Ruso part	0–14 14–22 22–60	2.0–6.0 2.0–6.0 >20.0	0.13–0.15 0.11–0.15 0.02–0.04	6.6–7.3 6.6–7.3 7.4–7.8
Manning part	0–6 6–21 21–60	2.0–6.0 2.0–6.0 >20.0	0.13–0.18 0.12–0.20 0.02–0.08	6.6–7.3 6.6–8.4 7.9–8.4
[1] RxB:				
Ruso part	0–14 14–22 22–60	2.0–6.0 2.0–6.0 >20.0	0.13–0.15 0.11–0.15 0.02–0.04	6.6–7.3 6.6–7.3 7.4–7.8
Manning part	0–6 6–21 21–60	2.0–6.0 2.0–6.0 >20.0	0.13–0.18 0.12–0.20 0.02–0.08	6.6–7.3 6.6–8.4 7.9–8.4
[1] RyC:				
Ruso part	0–14 14–22 22–60	2.0–6.0 2.0–6.0 >20.0	0.13–0.15 0.11–0.15 0.02–0.04	6.6–7.3 6.6–7.3 7.4–7.8
Wabek part	0–7 7–60	2.0–6.0 >20.0	0.20–0.22 0.02–0.04	6.6–7.3 7.4–7.8
Seroco:				
SeD	0–60	6.0–20.0	0.07–0.09	6.6–7.8
Sinai:				
Sn	0–21 21–37 37–60	0.06–0.2 0.06–0.2 0.06–0.2	0.13–0.19 0.11–0.17 0.11–0.17	6.1–7.3 7.4–8.4 7.4–8.4
Straw:				
St, [1] Sx	0–60	0.6–2.0	0.12–0.22	6.6–8.4
Telfer:				
[1] TlC:				
Telfer part	0–15 15–60	6.0–20 6.0–20	0.10–0.12 0.06–0.10	6.6–7.3 6.6–7.8
Lihen part	0–60	6.0–20	0.06–0.16	6.6–7.8

chemical properties—Continued

Salinity	Shrink-swell potential	Risk of corrosion: Uncoated steel	Risk of corrosion: Concrete	Wind erodibility group
Mmhos/cm				
<2	Moderate	Moderate	Low	6
<2	Low	Moderate	Low	
<2	Moderate	Moderate	Low	6
<2	Moderate	Moderate	Low	
<2	Moderate	Moderate	Low	6
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	3
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	3
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	3
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	3
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	3
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	3
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	3
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	3
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	5
<2	Low	Moderate	Low	
<2	Low	Low	Low	1
<2	High	High	Low	4
<2	High	High	Low	
<2	High	High	Low	
<2	Moderate	High	Low	6
<2	Low	Moderate	Low	2
<2	Low	Moderate	Low	
<2	Low	Moderate	Low	2

TABLE 12.—*Physical and*

Soil and map symbol	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
Tonka:				
[1] Tp:				
Tonka part	0–11	0.6–2.0	0.18–0.23	5.6–6.5
	11–17	0.06–0.2	0.14–0.19	5.6–7.3
	17–60	0.2–0.6	0.14–0.19	7.9–8.4
Parnell part	0–8	0.2–0.6	0.18–0.22	6.1–7.8
	8–38	0.06–0.2	0.13–0.19	6.6–7.8
	38–60	0.06–0.2	0.11–0.19	6.6–8.4
Trembles:				
Tr	0–60	2.0–6.0	0.10–0.16	7.4–8.4
Vebar:				
[1] VwC:				
Vebar part	0–38	2.0–6.0	0.15–0.17	6.1–7.8
	38–60			
Williams part	0–5	2.0–6.0	0.15–0.17	6.6–7.3
	5–16	0.6–2.0	0.16–0.20	6.6–7.8
	16–60	0.2–0.6	0.15–0.18	7.9–8.4
Wabek:				
[1] WaB:				
Wabek part	0–7	2.0–6.0	0.20–0.22	6.6–7.3
	7–60	>20.0	0.02–0.04	7.4–7.8
Max part	0–17	0.6–2.0	0.20–0.22	6.6–7.8
	17–60	0.2–0.6	0.14–0.19	7.9–8.4
Zahl part	0–6	0.6–2.0	0.20–0.22	7.4–7.8
	6–60	0.2–0.6	0.15–0.19	7.4–8.4
[1] WaD:				
Wabek part	0–7	2.0–6.0	0.20–0.22	6.6–7.3
	7–60	>20.0	0.02–0.04	7.4–7.8
Max part	0–17	0.6–2.0	0.20–0.22	6.6–7.8
	17–60	0.2–0.6	0.14–0.19	7.9–8.4
Zahl part	0–6	0.6–2.0	0.20–0.22	7.4–7.8
	6–60	0.2–0.6	0.15–0.19	7.4–8.4
[1] WbB, [1] WbD	0–7	2.0–6.0	0.20–0.22	6.6–7.3
	7–60	>20.0	0.02–0.04	7.4–7.8
Williams:				
WlB	0–5	0.6–2.0	0.17–0.24	6.6–7.3
	5–16	0.6–2.0	0.16–0.20	6.6–7.8
	16–60	0.2–0.6	0.15–0.18	7.9–8.4
WmA, WmB	0–5	0.6–2.0	0.17–0.24	6.6–7.3
	5–16	0.6–2.0	0.16–0.20	6.6–7.3
	16–60	0.2–0.6	0.15–0.18	7.9–8.4
[1] WoA:				
Williams part	0–5	0.6–2.0	0.17–0.24	6.6–7.3
	5–16	0.6–2.0	0.16–0.20	6.6–7.8
	16–60	0.2–0.6	0.15–0.18	7.9–8.4
Bowbells part	0–9	0.6–2.0	0.17–0.24	6.6–7.3
	9–25	0.6–2.0	0.16–0.22	6.6–7.3
	25–60	0.2–0.6	0.14–0.18	7.9–8.4
[1] WoB:				
Williams part	0–5	0.6–2.0	0.17–0.24	6.6–7.3
	5–16	0.6–2.0	0.16–0.20	6.6–7.8
	16–60	0.2–0.6	0.15–0.18	7.9–8.4

chemical properties—Continued

Salinity	Shrink-swell potential	Risk of corrosion		Wind erodibility group
		Uncoated steel	Concrete	
Mmhos/cm				
<2	Low	High	Low	6
<2	High	High	Low	
<2	Moderate	High	Low	
<2	Moderate	High	Low	7
<2	High	High	Low	
<2	High	High	Low	
<2	Low	High	Low	3
<2	Low	Moderate	Low	3
<2	Low	High	Low	3
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Low	Moderate	Low	5
<2	Low	Moderate	Low	
<2	Moderate	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	Moderate	Low	4L
<2	Moderate	Moderate	Low	
<2	Low	Moderate	Low	5
<2	Low	Moderate	Low	
<2	Moderate	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	Moderate	Low	4L
<2	Moderate	Moderate	Low	
<2	Low	Moderate	Low	5
<2	Low	Moderate	Low	
<2	Low	High	Low	8
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	

TABLE 12.—*Physical and*

Soil and map symbol	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
Bowbells part	0–9 9–25 25–60	0.6–2.0 0.6–2.0 0.2–0.6	0.17–0.24 0.16–0.22 0.14–0.18	6.6–7.3 6.6–7.3 7.9–8.4
[1] WoC:				
Williams part	0–5 5–16 16–60	0.6–2.0 0.6–2.0 0.2–0.6	0.17–0.24 0.16–0.20 0.15–0.18	6.6–7.3 6.6–7.8 7.9–8.4
Bowbells part	0–9 9–25 25–60	0.6–2.0 0.6–2.0 0.2–0.6	0.17–0.24 0.16–0.22 0.14–0.18	6.6–7.3 6.6–7.3 7.9–8.4
[1] WpB:				
Williams part	0–5 5–16 16–60	0.6–2.0 0.6–2.0 0.2–0.6	0.17–0.24 0.16–0.20 0.15–0.18	6.6–7.3 6.6–7.8 7.9–8.4
Bowbells part	0–9 9–25 25–60	0.6–2.0 0.6–2.0 0.2–0.6	0.17–0.24 0.16–0.22 0.14–0.18	6.6–7.3 6.6–7.3 7.9–8.4
Zahl part	0–6 6–60	0.6–2.0 0.2–0.6	0.20–0.22 0.15–0.19	7.4–7.8 7.4–8.4
[1] WrB:				
Williams part	0–5 5–16 16–60	0.6–2.0 0.6–2.0 0.2–0.6	0.17–0.24 0.16–0.20 0.15–0.18	6.6–7.3 6.6–7.8 7.9–8.4
Mine sink part.				
Wilton:				
WsA	0–27 27–60	0.6–2.0 0.2–0.6	0.22–0.24 0.15–0.19	6.6–7.3 7.4–8.4
[1] WtB:				
Wilton part	0–27 27–60	0.6–2.0 0.2–0.6	0.22–0.24 0.15–0.19	6.6–7.3 7.4–8.4
Temvik part	0–26 26–60	0.6–2.0 0.2–0.6	0.22–0.24 0.15–0.19	6.6–7.3 7.4–8.4
[1] WwC:				
Wilton part	0–27 27–60	0.6–2.0 0.2–0.6	0.22–0.24 0.15–0.19	6.6–7.3 7.4–8.4
Williams part	0–5 5–16 16–60	0.6–2.0 0.6–2.0 0.2–0.6	0.17–0.24 0.16–0.20 0.15–0.18	6.6–7.3 6.6–7.8 7.9–8.4
Zahl:				
[1] ZcE:				
Zahl part	0–6 6–60	0.6–2.0 0.2–0.6	0.20–0.22 0.15–0.19	7.4–7.8 7.4–8.4
Cabba part	0–17 17–60	0.6–2.0	0.12–0.15	6.6–7.8
[1] ZmE:				
Zahl part	0–6 6–60	0.6–2.0 0.2–0.6	0.20–0.22 0.15–0.19	7.4–7.8 7.4–8.4
Max part	0–17 17–60	0.6–2.0 0.2–0.6	0.20–0.22 0.14–0.19	6.6–7.8 7.9–8.4
[1] ZpE:				
Zahl part	0–6 6–60	0.6–2.0 0.2–0.6	0.20–0.22 0.15–0.19	7.4–7.8 7.4–8.4

chemical properties—Continued

Salinity	Shrink-swell potential	Risk of corrosion		Wind erodibility group
		Uncoated steel	Concrete	
Mmhos/cm				
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Moderate	Moderate	Low	4L
<2	Moderate	Moderate	Low	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Low	Moderate	Low	6
<2	Moderate	Moderate	Low	
<2	Low	Moderate	Low	6
<2	Moderate	Moderate	Low	
<2	Low	Moderate	Low	6
<2	Moderate	Moderate	Low	
<2	Low	Moderate	Low	6
<2	Moderate	Moderate	Low	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	
<2	Moderate	Moderate	Low	4L
<2	Moderate	Moderate	Low	
<4	Moderate	High	Low	6
<2	Moderate	Moderate	Low	4L
<2	Moderate	Moderate	Low	
<2	Moderate	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	Moderate	Low	4L
<2	Moderate	Moderate	Low	

TABLE 12.—*Physical and*

Soil and map symbol	Depth	Permeability	Available water capacity	Soil reaction
	In	*In/hr*	*In/in*	*pH*
Max part	0–17 17–60	0.6–2.0 0.2–0.6	0.20–0.22 0.14–0.19	6.6–7.8 7.9–8.4
Parnell part	0–8 8–38 38–60	0.2–0.6 0.06–0.2 0.06–0.2	0.18–0.22 0.13–0.19 0.11–0.19	6.1–7.8 6.6–7.8 6.6–8.4
[1] ZwC:				
Zahl part	0–6 6–60	0.6–2.0 0.2–0.6	0.20–0.22 0.15–0.19	7.4–7.8 7.4–8.4
Williams part	0–5 5–16 16–60	0.6–2.0 0.6–2.0 0.2–0.6	0.17–0.24 0.16–0.20 0.15–0.18	6.6–7.3 6.6–7.8 7.9–8.4

[1] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and

soils in engineering uses. These estimates are given for each major horizon, at the depths indicated, in the representative profile of each soil. The estimates are based on field observations and on test data for these and similar soils.

Permeability is estimated on the basis of known relationships among the soil characteristics observed in the field—particularly soil structure, porosity, and gradation or texture—that influence the downward movement of water in the soil. The estimates are for water movement in a vertical direction when the soil is saturated. Not considered in the estimates is lateral seepage or such transient soil features as plowpans and surface crusts. Permeability of the soil is an important factor to be considered in the planning and design of drainage systems, in evaluating the potential for septic tank systems and other waste disposal systems, and in many other aspects of land use and management.

Available water capacity is rated on the basis of soil characteristics that influence the ability of the soil to hold water and make it available to plants. Important characteristics are content of organic matter, soil texture, and soil structure. Shallow-rooted plants are not likely to use the available water from the deeper soil horizons. Available water capacity is an important factor in the choice of plants or crops to be grown and in the design of irrigation systems.

Soil reaction is expressed as range in pH values. The range in pH of each major horizon is based on many field checks. For many soils, the values have been verified by laboratory analyses. Soil reaction is important in selecting the crops and ornamental or other plants to be grown, in evaluating soil amendments for fertility and stabilization, and in evaluating the corrosivity of soils.

Salinity is expressed as the electrical conductivity of the saturation extract, in millimhos per centimeter at 25° C. Estimates are based on field and laboratory measurements at representative sites of the nonirrigated soils. The salinity of individual irrigated fields is largely affected by the quality of the irrigation water and the irrigation practices. Hence, the salinity of individual fields can differ greatly from the value given in table 12. Salinity affects the suitability of a soil for crop production, its stability when used as a construction material, and its potential to corrode metal and concrete.

Shrink-swell potential depends mainly on the amount and kind of clay in the soil. Laboratory measurements of the swelling of undisturbed clods were made for many soils. For others it was estimated on the basis of the kind of clay and on measurements of similar soils. Size of imposed loadings and the magnitude of changes in soil moisture content are also important factors that influence the swelling of soils. Shrinking and swelling of some soils can cause damage to building foundations, basement walls, roads, and other structures unless special designs are used. A *high* shrink-swell potential indicates that special design and added expense may be required if the planned use of the soil will not tolerate large volume changes.

Risk of corrosion, as used in table 12, pertains to potential soil-induced chemical action that dissolves or weakens uncoated steel or concrete. The rate of corrosion of uncoated steel is related to soil moisture, particle-size distribution, total acidity, and electrical conductivity of the soil material. The rating of soils for corrosivity to concrete is based mainly on the sulfate content, soil texture, and acidity. Protective measures for steel or more resistant concrete help to avoid or minimize damage resulting from the corrosion. Installations of steel that intersect soil boundaries or soil horizons are more susceptible to corrosion than installations entirely within one kind of soil or within one soil horizon.

Wind erodibility groups are used to predict the susceptibility of soils to blowing and to predict the amount of soil lost by blowing. The groups consist of soils that have similar properties that affect soil blowing, principally those that determine the stability of aggregates that resist breakdown by tillage and abra-

chemical properties—Continued

Salinity	Shrink-swell potential	Risk of corrosion		Wind erodibility group
		Uncoated steel	Concrete	
Mmhos/cm				
<2	Moderate	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	7
<2	High	High	Low	
<2	High	High	Low	
<2	Moderate	Moderate	Low	4L
<2	Moderate	Moderate	Low	
<2	Low	High	Low	6
<2	Moderate	High	Low	
<2	Moderate	High	Low	

behavior characteristics of the mapping unit.

sion by wind. Among properties that affect their wind erodibility groups are texture, organic matter content, the content of calcium carbonate, soil moisture, mineralogical composition, and susceptibility to frost action.

Soil and water features

Features that relate to runoff or infiltration of water, to flooding, to grading and excavation, and to subsidence and frost action of each soil are indicated in table 13. This information is helpful in planning land uses and engineering projects that are likely to be affected by the amount of runoff from watersheds, by flooding and a seasonal high water table, by the presence of bedrock or a cemented pan in the upper 5 or 6 feet of the soil, by subsidence, or by frost action.

Hydrologic groups are used to estimate runoff after rainfall. Soil properties that influence the minimum rate of infiltration into the bare soil after prolonged wetting are depth to a water table, water intake rate and permeability after prolonged wetting, and depth to layers of slowly or very slowly permeable soil.

Flooding is rated in general terms that describe the frequency, duration, and period of the year when flooding is most likely. The ratings are based on evidences in the soil profile of the effects of flooding, namely thin strata of gravel, sand, silt, or, in places, clay deposited by floodwater; irregular decrease in organic-matter content with increasing depth; absence of distinctive soil horizons that form in soils of the area that are not subject to flooding; local information about floodwater heights and the extent of flooding; and local knowledge that relates the unique landscape position of each soil to historic floods. Most soils in low positions on the landscape where flooding is likely to occur are classified as fluvents at the suborder level or as fluventic subgroups. See the section "Classification of Soils."

The generalized description of flood hazards is of value in land use planning and provides a valid basis for land use restrictions. The soil data are less specific, however, than those provided by detailed engineering surveys that delineate flood-prone areas at specific flood frequency levels.

High water table is the highest level of a saturated zone more than 6 inches thick in soils for a continuous period of more than 2 weeks during most years. The depth to a seasonal high water table applies to undrained soils. Estimates are based mainly on the relationship between grayish colors or mottles in the soil and the depth to free water observed during the course of the soil survey. Indicated are the depth to the seasonal high water table; the kind of water table, whether perched, artesian, or the upper part of the ground water table; and the months of the year that the high water commonly is present. Only those saturated zones above a depth of 5 or 6 feet are indicated.

Information about the seasonal high water table helps in assessing the need for specially designed foundations, the need for specific kinds of drainage systems, and the need for footing drains to insure dry basements. Such information is also needed to decide whether or not to construct basements and to determine how septic tank absorption fields and other underground installations will function. Also, a seasonal high water table affects ease of excavation.

Depth to bedrock is shown for all soils that are underlain by bedrock at depths of 5 to 6 feet or less. For many soils, limited ranges in depth to bedrock is a part of the definition of the soil series. The depths shown are based on measurements made in many soil borings and other observations during the soil mapping. The kind of bedrock and its relative hardness as related to ease of excavation is also shown. Rippable bedrock can be excavated with a single-tooth ripping attachment on a 200 horsepower tractor, but hard bedrock generally requires blasting.

Potential frost action refers to the likelihood of damage to pavements and other structures by frost heaving and low soil strength after thawing. Frost action is defined as freezing temperatures in the soil and movement of soil moisture into the freezing zone,

TABLE 13.—*Soil and*

[Absence of an entry indicates that the feature is not a concern.

Soil and map symbol	Hydrologic group	Flooding		
		Frequency	Duration	Months
Aquents: Ac	D	Frequent	Long	Apr-Jul
Aquolls: Af	D	Common	Very long	Nov-Oct
Arnegard: ArA, ArB, ArC	B	None		
Banks: [1] Ba, [1] Bk	A	None		
Bowbells: BoA	B	None		
[2] BsB: Bowbells part	B	None		
Williams part	B	None		
Bowdle: BwA	B	None		
[2] ByB: Bowdle part	B	None		
Stady part	B	None		
[2] ByC: Bowdle part	B	None		
Stady part	B	None		
Cabba: [2] CaE	C	None		
[2] CbF: Cabba part	C	None		
Shale outcrop part.				
Cohagen: [2] ChD: Cohagen part	B	None		
Vebar part	B	None		
[2] ChE: Cohagen part	B	None		
Vebar part	B	None		
Colvin: Co	C	Frequent	Long	Apr-Jun
Dimmick: Dm	D	Frequent	Long	Apr-Jun
Divide: Dv	B	None		
Falkirk: FaA, FaB	B	None		
[2] FbA: Falkirk part	B	None		
Max part	B	None		

water features

The symbol > means greater than]

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
0–5.0	Apparent	Sep-Jul	>60		High.
0–2.0	Apparent	Nov-Oct	>60		High.
>6.0			>60		Moderate.
4.0–6.0	Apparent	Nov-Jun	>60		Low.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			10–20	Rippable	Moderate.
>6.0			10–20	Rippable	Moderate.
>6.0			4–20	Rippable	Moderate.
>6.0			20–40	Rippable	Moderate.
>6.0			4–20	Rippable	Moderate.
>6.0			20–40	Rippable	Moderate.
1.0–3.0	Apparent	Sep-Jun	>60		High.
1.0–3.0	Apparent	Sep-Jun	>60		Moderate.
3.0–5.0	Apparent	Sep-Jun	>60		High.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.

TABLE 13.—*Soil and*

Soil and map symbol	Hydrologic group	Flooding		
		Frequency	Duration	Months
[2] FbB: Falkirk part	B	None		
Max part	B	None		
[2] FbC: Falkirk part	B	None		
Max part	B	None		
Farnuf: FfA, FfB	B	None		
Flasher: FlD, FlE	A	None		
Flaxton: FnA, FnB, FnC	A	None		
Fossum: Fs	C	Occasional	Brief	Apr-Jul
Grail: GaA, GaB	C	None		
Grano: Gn	D	Common	Long	Sep-Jun
Grassna: GoA	B	None		
Hamerly: HaA	C	None		
Harriet: [2] Hk: Harriet part	D	Occasional	Long	Apr-Jun
Saline land part.				
Havrelon: [1] Hn, [1] Ho	B	None		
Heil: Hs	D	Frequent	Long	Apr-Jun
Krem: KrB	A	None		
Lallie: La	D	Frequent	Long	Apr-Jun
Lihen: LeB, LeC	A	None		
[2] LgE: Lihen part	A	None		
Zahl part	B	None		
Linton: [2] LmB: Linton part	B	None		
Mandan part	B	None		
[2] LmC: Linton part	B	None		

water features—Continued

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	7–20	Rippable -------	Low.
>6.0	----------	----------	>60	----------	Moderate.
1.0–4.0	Apparent ----------	Nov-Oct ----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
0–3.0	Apparent ----------	Sep-Jun ----------	>60	----------	High.
>6.0	----------	----------	>60	----------	Moderate.
3.0–5.0	Apparent ----------	Sep-Jun ----------	>60	----------	High.
3.0–5.0	Apparent ----------	Sep-Jun ----------	>60	----------	High.
4.0–5.0	Apparent ----------	Sep-Jun ----------	>60	----------	Moderate.
3.0–5.0	Apparent ----------	Sep-Jun ----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
1.0–3.0	Apparent ----------	Sep-Jun ----------	>60	----------	High.
>6.0	----------	----------	>60	----------	Low.
>6.0	----------	----------	>60	----------	Low.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.

TABLE 13.—*Soil and*

Soil and map symbol	Hydrologic group	Flooding		
		Frequency	Duration	Months
Mandan part	B	None	---	---
[2] LmD: Linton part	B	None	---	---
Mandan part	B	None	---	---
[2] LmE: Linton part	B	None	---	---
Mandan part	B	None	---	---
Lohler: [1] Lw, [1] Ly	C	None	---	---
Makoti: Ma	B	None	---	---
Mandan: MdA, MdB, MdC	B	None	---	---
Marysland: Mf	D	Occasional	Brief	Apr-Nov
Max: MgB	B	None	---	---
[2] MhC: Max part	B	None	---	---
Bowbells part	B	None	---	---
Zahl part	B	None	---	---
[2] MlC: Max part	B	None	---	---
Zahl part	B	None	---	---
[2] MlD: Max part	B	None	---	---
Zahl part	B	None	---	---
Morton: MoC	B	None	---	---
Niobell: [2] NbA: Niobell part	C	None	---	---
Williams part	B	None	---	---
[2] NbB: Niobell part	C	None	---	---
Williams part	B	None	---	---
Noonan: [2] NmB: Noonan part	D	None	---	---
Miranda part	D	None	---	---
[2] NmD: Noonan part	D	None	---	---
Miranda part	D	None	---	---

water features—Continued

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
3.0–5.0	Apparent ----------	Sep-Jun ----------	>60	----------	Moderate.
5.0–6.0	Apparent ----------	Sep-Jun ----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
1.0–4.0	Apparent ----------	Nov-Jul ----------	>60	----------	High.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	20–40	Rippable ----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.
>6.0	----------	----------	>60	----------	Moderate.

TABLE 13.—*Soil and*

Soil and map symbol	Hydro-logic group	Flooding		
		Frequency	Duration	Months
Nutley: NtA, NtB	C	None		
Orthents: Or	D	None		
Parnell: Pa, Pe	D	Frequent	Long	Apr-Nov
Parshall: PhA, PhB, PhC, PhD, PoA, PoB	B	None		
Regent: RgC	C	None		
Rhoades: [2] RhB	C	None		
Riverwash: Rm.				
Roseglen: Ro	B	None		
[2] RpB: Roseglen part	B	None		
Tansem part	B	None		
[2] RpC: Roseglen part	B	None		
Tansem part	B	None		
Ruso: RsA, RzA	B	None		
[2] RtB: Ruso part	B	None		
Manning part	B	None		
[2] RtC: Ruso part	B	None		
Manning part	B	None		
[2] RxB: Ruso part	B	None		
Manning part	B	None		
[2] RyC: Ruso part	B	None		
Wabek part	B	None		
Seroco: SeD	A	None		
Sinai: Sn	C	None		
Straw: St, [2] Sx	B	Rare		

water features—Continued

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
>6.0			>60		Moderate.
>6.0			>60		Low.
0-2.0	Apparent	Jan-Dec	>60		High.
>6.0			>60		Moderate.
>6.0			20-40	Rippable	Low.
>6.0			>40	Rippable	Low.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Low.
>6.0			>60		Moderate.

TABLE 13.—*Soil and*

Soil and map symbol	Hydro-logic group	Flooding: Frequency	Flooding: Duration	Flooding: Months
Telfer:				
[1]TlC:				
Telfer part	A	None		
Lihen part	A	None		
Tonka:				
[1]Tp:				
Tonka part	C	Common	Long	Apr-Jun
Parnell part	D	Frequent	Long	Apr-Nov
Trembles:				
[1]Tr	B	None		
Vebar:				
[1]VwC:				
Vebar part	B	None		
Williams part	B	None		
Wabek:				
[2]WaB:				
Wabek part	B	None		
Max part	B	None		
Zahl part	B	None		
[2]WaD:				
Wabek part	B	None		
Max part	B	None		
Zahl part	B	None		
[2]WbB, [2]WbD	B	None		
Williams:				
WlB, WmA, WmB	B	None		
[2]WoA:				
Williams part	B	None		
Bowbells part	B	None		
[2]WoB:				
Williams part	B	None		
Bowbells part	B	None		
[2]WoC:				
Williams part	B	None		
Bowbells part	B	None		
[2]WpB:				
Williams part	B	None		
Bowbells part	B	None		
Zahl part	B	None		
[2]WrB:				
Williams part	B	None		
Mine sink part.				

water features—Continued

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
>6.0			>60		Low.
>6.0			>60		Low.
3.0–5.0	Apparent	Sep-Jun	>60		High.
0–2.0	Apparent	Jan-Dec	>60		High.
>6.0			>60		Moderate.
>6.0			20–40	Rippable	Moderate.
>6.0			>60		Moderate.
>6.0			>60		Low.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Low.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Low.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.

TABLE 13.—*Soil and*

Soil and map symbol	Hydro-logic group	Flooding		
		Frequency	Duration	Months
Wilton:				
WsA	B	None		
[1] WtB:				
Wilton part	B	None		
Temvik part	B	None		
[1] WwC:				
Wilton part	B	None		
Williams part	B	None		
Zahl:				
[1] ZcE:				
Zahl part	B	None		
Cabba part	C	None		
[1] ZmE:				
Zahl part	B	None		
Max part	B	None		
[1] ZpE:				
Zahl part	B	None		
Max part	B	None		
Parnell part	D	Frequent	Long	Apr-Nov
[1] ZwC:				
Zahl part	B	None		
Williams part	B	None		

[1] Soils formerly subject to flooding are now protected by Garrison Dam.

which causes the formation of ice lenses. Soil texture, temperature, moisture content, porosity, permeability, and content of organic matter are the most important soil properties that affect frost action. It is assumed that the soil is not covered by insulating vegetation or snow and is not artificially drained. Silty and clayey soils that have a high water table in winter are most susceptible to frost action. Well drained very gravelly or sandy soils are the least susceptible.

Formation and Classification of Soils

This section consists of two main parts. The first part tells how the factors of soil formation have affected the development of the soils in the survey area. The second explains the system of soil classification currently used in the United States and classifies each soil series according to that system.

Factors of Soil Formation

Soils form through natural processes acting on material deposited or accumulated by geologic agencies. The characteristics of the soil at any given point are determined by (1) the kind of parent material, (2) the climate under which the soil material has accumulated and existed since accumulation, (3) the plant and animal life on and in the soil, (4) the relief, or lay of the land, and (5) the length of time the forces of soil formation have acted on the soil material. The factors of soil formation are so closely interrelated in their effects on the soil that few generalizations can be made regarding the effect of any one factor unless conditions are specified for the other four. Many of the processes of soil development are unknown.

Parent material

During the Pleistocene epoch, the entire survey area was covered by glaciers (*3*). Most of the soils formed in parent material of glacial origin. This material con-

water features—Continued

High water table			Bedrock		Potential frost action
Depth	Kind	Months	Depth	Hardness	
Ft			*In*		
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			10-20	Rippable	Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
>6.0			>60		Moderate.
0-2.0	Apparent	Jan-Dec	>60		High.
>6.0			>60		Moderate.
>6.0			>60		Moderate.

[3] This mapping unit is made up of two or more dominant kinds of soil. See mapping unit description for the composition and behavior characteristics of the mapping unit.

sists of glacial till that was deposited by glacial ice, of glacial lake sediment that has accumulated in still water, and of glacial outwash that was deposited by moving water. Some soils formed in windblown deposits, some formed in recent alluvium deposited by streams, and others developed from shales and sandstones (fig. 15).

Differences among the soils are partly caused by the kinds of parent material in which the soil developed. For example, the soils that developed in loamy glacial till, such as Williams, Max, and Zahl soils, generally have a uniform loam or clay loam texture throughout the profile and have stones and pebbles scattered on the surface and in the soil mass. Those soils that developed in glacial lake sediment, such as Makoti and Roseglen soils, are well sorted and have a high proportion of clay, silt, and very fine sand. Ruso, Bowdle, and Wabek soils formed in glacial outwash material. This coarse material was sorted by the action of glacial melt water that deposited beds of sand and gravel and somewhat stratified beds of loamy material over the sand and gravel.

Climate

Climate is an active force in soil formation. It includes temperature, precipitation, intensity and time of storms, proportion of precipitation that occurs as snow, number of frost-free days, and length of the growing season. In a sense, climate provides the total energy budget for the formation of soils.

McLean County has warm summers and cold winters. Annual precipitation averages nearly 16 inches, more than half of which occurs during the growing season.

Rainfall and temperature directly affect the soils in the survey area through weathering of parent material; leaching and redistribution of carbonates and clay particles in the soil profile, as in Williams and Tonka soils; and in accumulation of soil organic matter, as in Arnegard and Bowbells soils. The climate is also responsible for the type of plant and animal life which have contributed to soil development.

Chemical processes of weathering proceed at a slower pace in McLean County than in warmer, more

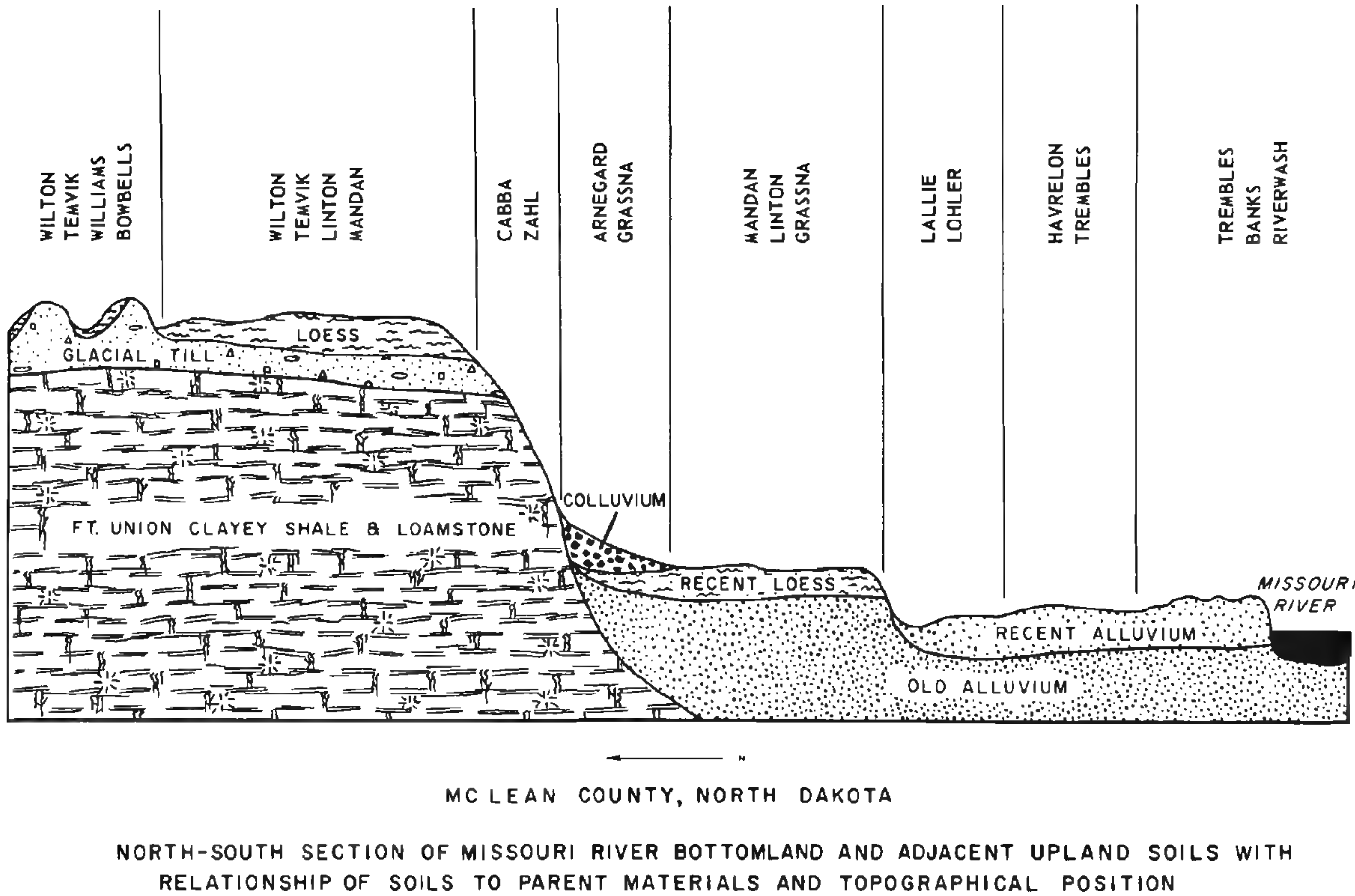

***Figure 15.*—Pattern of bottom land and adjacent upland soils and parent material along the Missouri River.**

humid parts of the country. Frozen ground prevents soil leaching in winter. In summer, rainfall peaks when evaporation and transpiration are approaching their maximum. Rapid evaporation and maximum growth at this period tend to decrease soil leaching. The older upland soils are leached of their carbonates to a depth of about 12 to 24 inches.

Plant and animal life

Native vegetation is mostly short, mid, and tall grasses. Composition varies according to site. Tall and mid grasses are dominant on soils that are on swales, such as Arnegard, Bowbells, and Grassna soils. Green needlegrass, western wheatgrass, needleandthread, little bluestem, big bluestem, and prairie sandreed are the dominant species. Short and mid grasses are dominantly on ridgetops and steep slopes. These include blue grama, plains muhly, side-oats grama, little bluestem, and threadleaf sedge. On poorly drained soils, such as Colvin, Grano, Marysland, and Parnell soils, the native vegetation is prairie cordgrass, rivergrass, slough sedge, American mannagrass, reeds, and cattails.

In McLean County, native vegetation produces large amounts of organic matter, which decays and is incorporated into the soil. Plant roots loosen the soil material and take up calcium, phosphorus, potassium, and other nutrients from the parent material; then they leave these elements near the surface when the plants die and decay. Thus nutrients leached from the surface layer are replaced, and a good supply is maintained for use by other plants.

Bacteria and fungi play an important role in the development of soils. They break down dead plant and animal life and help form it into humus. Some bacteria take nitrogen from the air and transform it so it can be used by plants. Earthworms, small rodents, insects, and snails also influence soil development. Man's activities, particularly in altering drainage conditions, maintaining fertility, and changing the kinds of vegetation, will have an important effect upon the rate and direction of soil formation of the future.

Relief

Relief, or lay of the land, influences soil formation by its effect on runoff, drainage, and erosion. Runoff is rapid on steep slopes, and only a small part of the rainfall penetrates the soil. Under these conditions,

there is little moisture for plant growth and soil development. The steep soils have thin surface layers, are low in organic-matter content, and have weak horizons. Examples are Zahl, Cabba, and Wabek soils.

Nearly level to rolling, sloping soils are well drained or moderately well drained. There is sufficient moisture penetration to support good stands of grasses. The soils have well developed profiles characterized by a dark colored A horizon and a brownish B horizon. Examples are Williams, Max, and Morton soils.

Concave depressional areas that receive large amounts of runoff from higher areas are poorly or very poorly drained. Most of these soils have a thick black A horizon, a mottled gray or olive subsoil, and a substratum similar to the subsoil. Examples are Parnell, Dimmick, and Tonka soils.

Time

Time is necessary for the factors of soil formation to act on parent material. For most soils a very long time is needed for the development of distinct soil horizons. Most of the soils in this survey area are mature, and they have well developed profile characteristics. The well drained soils, such as Williams soil, are among the most mature. Soils of the flood plains along the Missouri River are generally immature. In those areas the soil material has not been in place long enough for distinct horizons to develop. Havrelon, Banks, and Lohler are examples of soils with little or no horizon differentiation.

All soils in the survey area are relatively young because they formed from material deposited in late Pleistocene time, which ended about 9,000 years ago (*3*).

Classification of Soils

Soils are classified so that we can more easily remember their significant characteristics. Classification enables us to assemble knowledge about the soils, to see their relationship to one another and to the whole environment, and to develop principles that help us to understand their behavior and their response to manipulation. First through classification, and then through the use of soil maps, we can apply our knowledge of soils to specific fields and other tracts of land.

The narrow categories of classification, such as those in detailed soil surveys, allow us to organize and apply knowledge about soils in managing farms, fields, and woodlands; in developing rural areas; in engineering work; and in many other ways. Soils are classified in broad classes to facilitate study and comparison in large areas such as countries and continents.

The system of soil classification used by the National Cooperative Soil Survey (*9*) has six categories. Beginning with the broadest, these categories are the order, the suborder, the great group, the subgroup, the family, and the series. In this system the criteria used as a basis for classification are soil properties that are observable and measurable. The properties are chosen, however, so that the soils of similar genesis, or mode of origin, are grouped. The same property or subdivisions of this property may be used in several different categories. In table 14, the soil series of the survey area are placed in some categories of the current system. Classes of the current system are briefly defined in the following paragraphs.

ORDER. Ten soil orders are recognized. The properties used to differentiate among soil orders are those that tend to give broad climatic groupings of soils. The three exceptions to this are the Entisols, Histosols, and Vertisols, which occur in many different climates. Each order is identified by a word of three or four syllables ending in *sol* (Moll-i-sol). The two soil orders in the survey area (see table 14) are Mollisols and Entisols.

SUBORDER. Each order is divided into suborders according to those soil characteristics that seem to produce classes with the greatest genetic similarity. The suborders are more narrowly defined than the orders. The soil properties used to separate suborders are mainly those that reflect either the presence or absence of a water table at a shallow depth; soil climate; the accumulation of clay, iron, or organic carbon in the upper solum; cracking of soils caused by a decrease in soil moisture; and fine stratification. Each suborder is identified by a word of two syllables. The last syllable indicates the order. An example is Aquoll (Aqu, meaning water or wet, or oll, from Mollisol).

GREAT GROUP. Each suborder is divided into great groups on the basis of uniformity in the kinds and sequence of soil horizons and features. The horizons used to make separations are those in which clay, carbonates, and other constituents have accumulated or have been removed and those that have pans that interfere with growth of roots, movement of water, or both. The features used are soil acidity, soil climate, soil composition, and soil color. Each great group is identified by a word of three or four syllables; a prefix is added to the name of the suborder. An example is Haplaquoll (Hapl, meaning simple horizons; aqu, for wetness or water; and oll, from Mollisols). The great group is not shown separately in table 14 because it is the last word in the name of the subgroup.

SUBGROUP. Each great group is divided into subgroups; one representing the central (typic) segment of the group; and the others, called intergrades, that have properties of the group and one or more properties of another great group, suborder, or order. Other subgroups may have soil properties unlike those of any other great group, suborder, or order. Each subgroup is identified by the name of the great group preceded by one or more adjectives. An example is Typic Haplaquolls (a typical Haplaquoll).

FAMILY. Soil families are established within a subgroup primarily on the basis of properties important to the growth of plants or to the behavior of soils when used for engineering. Among the properties considered are texture, mineralogy, reaction, soil temperature, permeability, soil depth, and consistence. A family name is the subgroup name preceded by a series of adjectives, the class names for texture and mineralogy; for example, the fine-loamy, mixed family of Typic Haploborolls.

Mechanical and Chemical Analysis

Detailed mechanical and chemical analysis of the

TABLE 14.—*Classification of the soils*

[An asterisk in the first column indicates that the soil is a taxadjunct to the series. See text for a description of those characteristics of the soil that are outside the range of the series]

Soil name	Family or higher taxonomic class
Aquents	Loamy, mixed, frigid Aquents
Aquolls	Mixed, frigid Aquolls
Arnegard	Fine-loamy, mixed Pachic Haploborolls
Banks	Sandy, mixed, frigid Typic Ustifluvents
Bowbells	Fine-loamy, mixed Pachic Argiborolls
Bowdle	Fine-loamy over sandy or sandy-skeletal, mixed Pachic Haploborolls
Cabba	Loamy, mixed (calcareous), frigid, shallow Typic Ustorthents
Cohagen	Loamy, mixed (calcareous), frigid, shallow Typic Ustorthents
Colvin	Fine-silty, frigid Typic Calciaquolls
Dimmick	Fine, montmorillonitic, frigid Vertic Haplaquolls
Divide	Fine-loamy over sandy or sandy-skeletal, frigid Aeric Calciaquolls
Falkirk	Fine-loamy, mixed Pachic Haploborolls
Farnuf	Fine-loamy, mixed Typic Argiborolls
Flasher	Mixed, frigid, shallow Typic Ustipsamments
Flaxton	Fine-loamy, mixed Pachic Argiborolls
Fossum	Sandy, mixed, frigid Typic Haplaquolls
Grail	Fine, montmorillonitic Pachic Argiborolls
Grano	Fine, montmorillonitic (calcareous), frigid Vertic Haplaquolls
Grassna	Fine-silty, mixed Pachic Haploborolls
Hamerly	Fine-loamy, frigid Aeric Calciaquolls
Harriet	Fine, mixed, frigid Typic Natraquolls
Havrelon	Fine-loamy, mixed (calcareous), frigid Typic Ustifluvents
Heil	Fine, montmorillonitic, frigid Typic Natraquolls
Krem	Sandy over loamy, mixed Typic Argiborolls
Lallie	Fine, montmorillonitic (calcareous), frigid Typic Fluvaquents
Lihen	Sandy, mixed Entic Haploborolls
Linton	Coarse-silty, mixed Typic Haploborolls
Lohler	Fine, montmorillonitic (calcareous), frigid Typic Ustifluvents
Makoti	Fine-silty, mixed Pachic Haploborolls
Mandan	Coarse-silty, mixed Pachic Haploborolls
Manning*	Coarse-loamy over sandy or sandy-skeletal, mixed Typic Haploborolls
Marysland	Fine-loamy over sandy or sandy-skeletal, frigid Typic Calciaquolls
Max	Fine-loamy, mixed Typic Haploborolls
Miranda	Fine-loamy, mixed Leptic Natriborolls
Morton	Fine-silty, mixed Typic Argiborolls
Niobell	Fine-loamy, mixed Glossic Natriborolls
Noonan	Fine-loamy, mixed, Typic Natriborolls
Nutley*	Fine, montmorillonitic Udertic Haploborolls
Orthents	Loamy, mixed, frigid Orthents
Parnell	Fine, montmorillonitic, frigid Typic Argiaquolls
Parshall	Coarse-loamy, mixed Pachic Haploborolls
Regent	Fine, montmorillonitic Typic Argiborolls
Rhoades	Fine, montmorillonitic Leptic Natriborolls
Roseglen	Fine-loamy, mixed Pachic Haploborolls
Ruso	Coarse-loamy, mixed Pachic Haploborolls
Seroco	Mixed, frigid Typic Ustipsamments
Sinai*	Fine, montmorillonitic Pachic Udic Haploborolls
Stady	Fine-loamy over sandy or sandy-skeletal, mixed Typic Haploborolls
Straw	Fine-loamy, mixed Cumulic Haploborolls
Tansem	Fine-loamy, mixed Typic Haploborolls
Telfer	Sandy, mixed Entic Haploborolls
Temvik	Fine-silty, mixed Typic Haploborolls
Tonka	Fine, montmorillonitic, frigid Argiaquic Argialbolls
Trembles	Coarse-loamy, mixed (calcareous), frigid Typic Ustifluvents
Vebar	Coarse-loamy, mixed Typic Haploborolls
Wabek	Sandy-skeletal, mixed Entic Haploborolls
Williams	Fine-loamy, mixed Typic Argiborolls
Wilton	Fine-silty, mixed Pachic Haploborolls
Zahl	Fine-loamy, mixed Entic Haploborolls

following soils in the survey area are given in a mimeographed report *Field and Laboratory Data, North Dakota Soils, 1971–1972:* Bowdle loam SU72ND–28–1, Bowbells loam SU72ND–28–2, Williams loam SU72ND–28–3, Ruso coarse sandy loam SU72ND–28–4, Max loam SU72ND–28–5, and Zahl loam SU72ND–28–6. Soil Survey Investigations Report Number 2 *Soil Survey Laboratory Data and Description for Some Soils of North Dakota* contains detailed information on several soil series that are in the survey area but were sampled in adjoining counties.

These data are useful to soil scientists in classifying soils and in developing concepts of soil genesis. They are helpful in estimating available water capacity,

wind erodibility, fertility, tilth, and other properties that affect practical aspects of soil management.

Environmental Factors Affecting Soil Use

According to *Journals of Lewis and Clark* (*6*), Captain Meriwether Lewis and William Clark and their party spent from November 20, 1804 to April 7, 1805 approximately 14 miles west of Washburn on the east bank of the Missouri River. They constructed a small log fort for protection and shelter. It was named Ft. Mandan for the friendly Mandan Indians whose village was nearby (*10*). A replica of Ft. Mandan has recently been constructed near the original site and is maintained as a historical site.

Riverboats began traveling up the Missouri River. Washburn, one of the earliest steamboat landings in the State, was an important shipping and trading center in pioneer days. The town of Washburn was officially founded in 1882. Fort Stevenson, a military post, was established south of the present town of Garrison in 1867–68. Garrison was started in 1903.

In 1883 McLean County was created out of Dakota Territory. After several changes, the present boundary was established December 24, 1908. Homesteading began in the early 1880's and continued until approximately 1900. The first railroad came to Washburn in 1901 and to Turtle Lake in 1905.

According to the 1970 census, the population of McLean County was 11,251. Washburn, the county seat, had a population of 804; Garrison, the largest town, had 1,614; Turtle Lake, 712; Underwood, 781; Wilton, 695; Butte, 193; Max, 301; Mercer, 132; and Riverdale, 545. Smaller communities are Benedict, Whiteshield, Roseglen, Ruso, Emmett, Coleharbor, Falkirk, and Raub.

Most industry in this county is related to buying and selling agricultural products. Two small manufacturing plants are in the county.

U.S. Highway 83 extends from Wilton in the southeast corner of the county through Washburn and Underwood to Max at the north border. State Highways 41, 37, 200, 1804 cross the county so that very few places are more than 10 miles from a hard surfaced highway. Well maintained gravel roads provide easy access to markets from all parts of the county.

Physiography, Relief, and Drainage

McLean County is in glaciated plains in the central part of North Dakota. The Tongue River and Sentinel Butte Formations, members of the Fort Union Group, lie directly beneath the glacial drift. Soft shale and sandstone of the Fort Union Group are exposed in many areas of the county. Glacial drift occurs throughout the survey area and reaches a maximum thickness of at least 400 feet in certain preglacial valleys, although the average is about 120 feet thick throughout the county. Near the Missouri River and over most of the western part of the survey area, the average is less than 50 feet thick. This glacial drift belongs to the Coleharbor Formation and is of the Wisconsin age (*3*).

The highest point in the survey area is the 2,445-foot hill approximately 8 miles northwest of the community of Emmett. Another high point is Dogden Butte with an elevation of 2,285 feet. The low area in the county is the Missouri River bottom land, near the Burleigh County line, where the elevation is approximately 1,650 feet.

The eastern and northeastern section of the county, which is part of the Missouri Coteau, is characterized by short, irregular slopes on hilly, dead-ice moraine, numerous kames, kettles, lake plains, and outwash-deposited material. In these areas the slopes are 6 to 25 percent. Much of the remaining part is Coteau slope, which has a gently rolling surface on ground moraine. Short, irregular slopes of 1 to 9 percent characterize this area. Gently sloping areas and slightly lower relief characterize the areas of glacial melt water deposits. Short, irregular slopes and gradients up to 20 percent are common in areas of sandy melt water deposits. Near the Missouri River, glacial deposits and soft shales are mantled by loess. The mantle is more than 5 feet thick in the level areas adjacent to the river and becomes thinner with increasing distance from the river. Along the breaks of the Missouri River the slope gradient is 20 percent or more.

Recent alluvium covers the flood plains of the Missouri River. Seasonal runoff flooded this bottom land before the completion of Garrison Dam. The flood plain is nearly level except for short slopes between benches.

The Continental Divide between the watershed of Hudson Bay to the north and the Missouri and Mississippi rivers crosses the county in the extreme northeastern part. Approximately 50 sections drain toward the north. The Missouri River and its tributaries provide surface drainage to the south. The main creeks are Painted Woods, Turtle, Buffalo, Snake, Douglas, and Deep Water. In the eastern and northeastern parts of the county, in the dead-ice moraine, the drainage is in local depressions and potholes.

Climate [7]

The climate of McLean County is typically continental. Temperatures have a large range of values, both annually and daily. Cold and dry air masses from the polar regions intensify winters. Warm and moist air masses from the Gulf of Mexico dictate most precipitation characteristics. Because of the geographical location of the area, the hours of daylight range from less than 9 in December to more than 16 in June.

Air temperature.—Typical of the continental climate and the northerly location in the United States, the air temperatures in McLean County vary considerably. The mean annual temperatures of 40° F to 41° indicate little of the temperature in the area. Table 15, however, shows average daily temperatures ranging from 7.2° in January to 70.2° in July. The average daily minimum in January is −2.9°, and the average daily maximum in July is 83.5°.

Minimum daily temperatures are above freezing on

[7] By J. M. RAMIREZ, associate professor of soils, Climatology, North Dakota State University.

TABLE 15.—*Temperature, precipitation, and cloudiness data*

Month	Temperature			Precipitation		Average number of days		
	Average daily maximum	Average daily minimum	Average daily	Average	Average snowfall	Clear	Partly cloudy	Cloudy
	°F	°F	°F	In	In			
January	17.3	−2.9	7.2	.50	5.00	6	9	16
February	23.2	2.2	12.7	.46	4.75	5	8	15
March	34.4	13.6	24.0	.60	4.50	6	8	17
April	53.1	29.5	41.4	1.45	3.72	6	9	15
May	66.6	40.9	53.8	2.20	.27	6	11	14
June	75.3	51.1	63.2	3.68	0	7	10	13
July	83.5	56.8	70.2	2.55	0	12	12	7
August	82.4	54.3	68.5	1.95	0	13	10	8
September	70.6	43.5	57.2	1.37	.06	10	8	12
October	58.8	33.3	46.1	.68	.91	10	8	13
November	38.3	18.1	28.1	.52	3.01	6	8	16
December	25.1	5.9	15.5	.41	3.72	6	7	18
Year	52.4	28.8	40.6	16.37	25.94	93	108	164

only 125 days of the year in the survey area. In the average fall season, the first freeze is expected about September 24. The last freeze in spring occurs about May 20.

The length of the frost-free period is based on temperatures observed in shelters exposed 5 feet above ground level. It is not unusual for air temperatures closer to the ground to be 3° to 7° lower than those measured inside an instrument shelter. This is particularly true on clear and calm nights and in early mornings when radiation loss from the ground and overlying air layers is unimpeded by clouds.

In McLean County, small grain is usually planted when mean temperatures are about 40° F.

The following tabulation shows the probability of an average weekly temperature above 40° F:

	Percent probability
March 22–28	10–15
March 29–April 4	15–20
April 5–11	30–35
April 12–18	60–65
April 19–25	75–80
April 26–May 2	80–90

In planning agronomic and other outdoor activities, the occurrence of freezing temperatures can become critical in scheduling. The probability of frost occurring in the survey area in spring and fall is shown in the following tabulation:

	Percent probability
May 3–9	80–85
May 17–23	40–45
May 31–June 6	10–15
August 30–September 5	10–15
September 13–19	45–50
September 27–October 3	75–80

As late as the last week in May, there is about a 25 to 30 percent chance of frost. As early as mid-September there is a more than 50 percent chance of frost in the mornings.

A fair indication of persisting high temperatures is the number of days when maximum temperatures exceed 90° F. These conditions are negatively correlated to crop yields in North Dakota. On the average, in 17 days of the year in this survey area the maximum daily temperatures exceed 90°. During the hottest days of the year, from the last week in July through mid-August, there is at least a 70 to 75 percent chance that on one day of the week, the maximum temperature will exceed 90°.

Subzero temperatures are fair and convenient indicators of extreme cold. When these temperatures are accompanied by high winds, livestock must receive special protection, and outdoor activity is greatly curtailed or made more difficult. The chances of subzero temperatures occurring for 5 consecutive days are as follows:

	Percent probability
December 13-19	25–30
December 27–January 2	30–35
January 10–16	40–45
January 24–30	45–50
February 7–13	25–30
February 21–29	20–25

Prolonged above-freezing temperatures in winter play a major role in planning and completing outdoor work in construction and other engineering activities. Such information also lends significance to snow cover amounts as related to flood forecasting and to soil thawing and freezing problems associated with soil heaving. The chance that temperatures will be above freezing for 5 consecutive days in winter is shown in the following tabulation:

	Percent probability
October 25–31	95–100
November 8–14	55–60
December 6–12	20–25
January 3–9	10–15
January 31–February 6	15–20
March 1–7	25–30
March 29–April 4	80–85

Precipitation.—On the average, throughout the year the survey area receives only about 16 to 17 inches of precipitation, mostly in the form of rain. Despite this low amount of precipitation, which puts the county under subhumid climatic classification, the industry and small grain farms in the area benefit from the fact that over 80 percent of the annual precipitation falls from April through September. This is evident in the monthly distribution of rainfall shown in table 15. Rainfall in spring is usually light, increasing until late in June and gradually declining in winter.

In the last 70 years, Garrison Station has recorded more than 20 inches of annual precipitation in each of 7 isolated years, and the records for 3 other years are as low as 10 inches.

Weekly precipitation in the county gradually increases in the beginning of spring from about one-tenth of an inch per week to a little less than one inch per week in the first week of June. After this time, it gradually starts to decrease again to less than one-tenth of an inch in early October. The chances of receiving at least one-half inch of rain per week in March, April, and May are less than 10 to about 30 percent. This amount per week compares closely to the average amount of evaporation losses in the cool months of spring.

During the hot summer when moisture deficits are more critical, about one-fourth inch of water can be lost daily by an open evaporating surface, although loss by crops is usually less.

Approximately one-fourth of the annual precipitation falls as snow. In winter, about 40 days when at least 6 inches of snow is on the ground can be expected. The first inch of accumulation can be expected in the first week of December, on the average, while the last inch comes as late as the last week in March. These dates correspond to average conditions when at least an inch of snow is still on the ground.

Wind.—Prevailing wind directions at three nearby National Weather Service Stations show that westerly winds prevail during winter from November through early spring. From May through summer and fall, variable southeasterly winds prevail. Average windspeeds are from 9 to 11 miles per hour.

Severe storms.—Most of the summer precipitation is associated with severe storm activity, such as thunderstorms. Around 23 thunderstorm days occur each year. The peak activity is in July when an average of about 8 days a month have some thunderstorm activity.

Tornadoes and the associated damaging forces can also occur. The peak hail activity is in June, July, and August. Approximately 50 hail damage reports have been made during a 20-year period.

Humidity.—Relative humidity and dew-point temperatures are convenient indicators of air moisture, although they are not necessarily as useful for technical purposes as some other indices. In midwinter, relative humidity values are highest for the year, ranging from 68 to 75 percent throughout the day. Much lower humidities in summer and late fall afternoons make human comfort indices in the area pleasant. Dew-point temperatures range from just above 0° in winter to 50° in summer, following very closely the air temperature trends.

Drought and wet spells.—The interaction of the two important elements of climate, precipitation and temperature, may be expressed in the history of drought and wet spells. A water balance model considering climate, plants in the area, and incident soils was developed by Ramirez and Cassel[8] to simulate this history. This water balance model used on long term records shows that 16 drought and 17 wet spells occurred in the area from 1930 through 1970. The drought index was negative more than half of this period, indicating at least some restrictions on crops during the growing season. The long, severe droughts of the 1930's and wet spells in the 1940's are followed by alternations of moderate surpluses and deficits of surface moisture. Spells in the late 1960's are markedly wetter than in earlier years.

Water Supply

Water is easy to find in nearly all parts of the survey area. Farm wells average about 200 feet and provide adequate water for domestic and livestock use. Water comes from Ft. Union Sandstone strata or from coal strata. It is usually of satisfactory quality, but some water contains considerable alkaline salts. Sources of water mainly for livestock are dugouts or surface reservoirs. In soils that have a high water table, such as Colvin and Marysland, the water level is maintained by seepage into these surface excavations.

A large aquifer is northwest of Turtle Lake. Several others are located throughout the county (*4*). The source of water for these aquifers is thick beds of gravel in buried ancient channels. Water of good quality in quantities over 1,500 gallons per minute has been obtained. Irrigated farming is developing rapidly in these areas using water from wells. According to the 1970 census, 772 acres was irrigated. A total of 3,473 acres was developed for irrigation by the end of the growing season in 1973.

Lake Sakakawea lies along McLean County for approximately 60 miles and could provide a source of water for a variety of uses. A few farmers pump directly from the lake for irrigation. The Garrison Diversion Canal is being constructed across the county southeast of Lake Audubon. It is planned to furnish irrigation water to many thousands of acres in central North Dakota. There are no plans at present for irrigation in the survey area using water from the canal.

Natural Resources

The principal natural resource in the survey area is

[8] Drought and Wet Spells in North Dakota. This manuscript is for future publication.

the high percentage of good quality farmland. There is also abundant gravel suitable for construction of roads and other engineering structures. A generous supply of lignite underlies most of the survey area. Several underground mines and surface strip mines have operated for many years in the vicinity of Wilton, Washburn, Underwood, Garrison, and Emmet. Work toward construction of an electric generating plant began in late 1973, and plans for a large scale lignite strip mine near Falkirk are being formulated.

Farming

Farming is the main enterprise in McLean County. In 1970 there were 1,439 farms in the county (*5*). The average size of the farm was 874 acres. The number and sizes of farms in the county in 1970 were as follows:

	Number	*Percent*
Farms:		
Less than 180 acres	170	11.8
180–499 acres	253	17.6
500–999 acres	533	37.0
1,000 or more acres	483	33.6

Ninety-five percent of the survey area is in farms, 73 percent is in crops, and 16 percent is in range.

The main field crops are spring wheat, Durum wheat, oats, barley, flax, and hay. The acreages of some crops grown in 1970 were as follows (*5*):

	Acres
Spring wheat	171,500
Durum wheat	98,000
Oats	81,000
Barley	30,500
Flax	69,000
Hay:	
Alfalfa	29,000
Other tame hay	26,000
Wild hay	47,000

Other crops grown in this area are corn, rye, sunflower, sudangrass, sugar beets, and potatoes. The crops grown under irrigation are mostly alfalfa hay and corn for silage. A few farmers raise sugar beets and other crops.

Raising beef cattle is the second most important farming enterprise. Most of the herds are small and of the cow-calf type. There are a few large ranches. A few dairy herds are in this county as well as a few small flocks of sheep and some hogs. The number of livestock on farms in 1970 was as follows:

Cattle and calves	68,000
Dairy cows	3,000
Sheep	5,100
Hogs	6,100

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Glossary

Aeration, soil. The exchange of air in soil with air from the atmosphere. The air in a well aerated soil is similar to that in the atmosphere; the air in a poorly aerated soil is considerably higher in carbon dioxide and lower in oxygen.

Aggregate, soil. Many fine particles held in a single mass or cluster. Natural soil aggregates, such as granules, blocks, or prisms, are called peds. Clods are aggregates produced by tillage or logging.

Alkali (sodic) soil. A soil having so high a degree of alkalinity (pH 8.5 or higher), or so high a percentage of exchangeable sodium (15 percent or more of the total exchangeable bases), or both, that plant growth is restricted.

Alluvium. Material, such as sand, silt, or clay, deposited on land by streams.

Area reclaim. An area difficult to reclaim after the removal of soil for construction and other uses. Revegetation and erosion control are extremely difficult.

Available water capacity (available moisture capacity). The capacity of soils to hold water available for use by most plants. It is commonly defined as the difference between the amount of soil water at field moisture capacity and the amount at wilting point. It is commonly expressed as inches of water per inch of soil. The capacity, in inches, in a 60-inch profile or to a limiting layer is expressed as—

	Inches
Very low	0 to 3
Low	3 to 6
Moderate	6 to 9
High	More than 9

Base saturation. The degree to which material having base exchange properties is saturated with exchangeable bases (sum of Ca, Mg, Na, K), expressed as a percentage of the exchange capacity.

Buried soil. A developed soil, once exposed but now overlain by more recently formed soil.

Calcareous soil. A soil containing enough calcium carbonate (commonly with magnesium carbonate) to effervesce (fizz) visibly when treated with cold, dilute hydrochloric acid. A soil having measurable amounts of calcium carbonate or magnesium carbonate.

Clay. As a soil separate, the mineral soil particles less than 0.002 millimeter in diameter. As a soil textural class, soil material that is 40 percent or more clay, less than 45 percent sand, and less than 40 percent silt.

Clay film. A thin coating of oriented clay on the surface of a soil aggregate or lining pores or root channels. Synonyms: clay coat, clay skin.

Claypan. A slowly permeable soil horizon that contains much more clay than the horizons above it. A claypan is commonly hard when dry and plastic or stiff when wet.

Compressible. Excessive decrease in volume of soft soil under load.

Consistence, soil. The feel of the soil and the ease with which a lump can be crushed by the fingers. Terms commonly used to describe consistence are—

Loose.—Noncoherent when dry or moist; does not hold together in a mass.

Friable.—When moist, crushes easily under gentle pressure between thumb and forefinger and can be pressed together into a lump.

Firm.—When moist, crushes under moderate pressure between thumb and forefinger, but resistance is distinctly noticeable.

Plastic.—When wet, readily deformed by moderate pressure but can be pressed into a lump; will form a "wire" when rolled between thumb and forefinger.

Sticky.—When wet, adheres to other material and tends to stretch somewhat and pull apart rather than to pull free from other material.

Hard.—When dry, moderately resistant to pressure; can be broken with difficulty between thumb and forefinger.

Soft.—When dry, breaks into powder or individual grains under very slight pressure.

Cemented.—Hard; little affected by moistening.

Cutbanks cave. Unstable walls of cuts made by earthmoving equipment. The soil sloughs easily.

Depth to rock. Bedrock at a depth that adversely affects the specified use.

Erosion. The wearing away of the land surface by running water, wind, ice, or other geologic agents and by such processes as gravitational creep.

Erosion (geologic). Erosion caused by geologic processes acting over long geologic periods and resulting in the wearing away of mountains and the building up of such landscape features as flood plains and coastal plains. Synonym: natural erosion.

Erosion (accelerated). Erosion much more rapid than geologic erosion, mainly as a result of the activities of man or other animals or of a catastrophe in nature, for example, fire, that exposes a bare surface.

Excess alkali. Excess exchangeable sodium. The resulting poor physical properties restrict the growth of plants.

Excess fines. Excess silt and clay. The soil does not provide a source of gravel or sand for construction purposes.

Fast intake. The rapid movement of water into the soil.

Frost action. Freezing and thawing of soil moisture. Frost action can damage structures and plant roots.

Glacial drift (geology). Pulverized and other rock material transported by glacial ice and then deposited. Also the assorted and unassorted material deposited by streams flowing from glaciers.

Glacial outwash (geology). Gravel, sand, and silt, commonly stratified, deposited by melt water as it flows from glacial ice.

Glacial till (geology). Unassorted, nonstratified glacial drift consisting of clay, silt, sand, and boulders transported and deposited by glacial ice.

Gleyed soil. A soil having one or more neutral gray horizons as a result of waterlogging and lack of oxygen. The term "gleyed" also designates gray horizons and horizons having yellow and gray mottles as a result of intermittent waterlogging.

Grassed waterway. A natural or constructed waterway, typically broad and shallow, seeded to grass as protection against erosion. Conducts surface water away from cropland.

Horizon, soil. A layer of soil, approximately parallel to the surface, having distinct characteristics produced by soil-forming processes. The major horizons of mineral soil are as follows:

O horizon.—An organic layer, fresh and decaying plant residue, at the surface of a mineral soil.

A horizon.—The mineral horizon, formed or forming at or near the surface, in which an accumulation of humified organic matter is mixed with the mineral material. Also, a plowed surface horizon most of which was originally part of a B horizon.

A2 horizon.—A mineral horizon, mainly a residual concentration of sand and silt high in content of resistant minerals as a result of the loss of silicate clay, iron, aluminum, or a combination of these.

B horizon.—The mineral horizon below an A horizon. The B horizon is in part a layer of change from the overlying A to the underlying C horizon. The B horizon also has distinctive characteristics caused (1) by accumulation of clay, sesquioxides, humus, or a combination of these; (2) by prismatic or blocky structure; (3) by redder or browner colors than those in the A horizon; or (4) by a combination of these. The combined A and B horizons are generally called the solum, or true soil. If a soil lacks a B horizon, the A horizon alone is the solum.

C horizon.—The mineral horizon or layer, excluding indurated bedrock, that is little affected by soil-forming processes and does not have the properties typical of the A or B horizon. The material of a C horizon may be either like or unlike that from which the solum is presumed to have formed. If the material is known to differ from that in the solum the Roman numeral II precedes the letter C.

R layer.—Consolidated rock beneath the soil. The rock commonly underlies a C horizon, but can be directly below an A or a B horizon.

Humus. The well decomposed, more or less stable part of the organic matter in mineral soils.

Lacustrine deposit (geology). Material deposited in lake water and exposed when the water level is lowered or the elevation of the land is raised.

Leaching. The removal of soluble material from soil or other material by percolating water.

Loess. Fine grained material, dominantly of silt-sized particles, deposited by wind.

Low strength. Inadequate strength for supporting loads.

Mottling, soil. Irregular spots of different colors that vary in number and size. Mottling generally indicates poor aeration and impeded drainage. Descriptive terms are as follows: abundance—few, common, and many; size—fine, medium, and coarse; and contrast—faint, distinct, and prominent. The size measurements are of the diameter along the greatest dimension. Fine indicates less than 5 millimeters (about 0.2 inch); medium, from 5 to 15 millimeters (about 0.2 to 0.6 inch); and coarse, more than 15 millimeters (about 0.6 inch).

Munsell notation. A designation of color by degrees of the three single variables—hue, value, and chroma. For example, a notation of 10YR 6/4 is a color of 10YR hue, value of 6, and chroma of 4.

Nutrient, plant. Any element taken in by a plant, essential to its growth, and used by it in the production of food and tissue. Plant nutrients are nitrogen, phosphorus, potassium, calcium, magnesium, sulfur, iron, manganese, copper, boron, zinc, and perhaps other elements obtained from the soil; and carbon, hydrogen, and oxygen obtained largely from the air and water.

Organic matter. A general term for plant and animal material, in or on the soil, in all stages of decomposition. Readily decomposed organic matter is often distinguished from the more stable forms that are past the stage of rapid decomposition.

Parent material. The great variety of unconsolidated organic and mineral material in which soil forms. Consolidated bedrock is not yet parent material by this concept.

Ped. An individual natural soil aggregate, such as a granule, a prism, or a block.

Percs slowly. The slow movement of water through the soil adversely affecting the specified use.

Permeability. The quality that enables the soil to transmit water or air, measured as the number of inches per hour that water moves through the soil. Terms describing permeability are very slow (less than 0.06 inch), slow (0.06 to 0.20 inch), moderately slow (0.2 to 0.6 inch), moderate (0.6 to 2.0 inches), moderately rapid (2.0 to 6.0 inches), rapid (6.0 to 20 inches), and very rapid (more than 20 inches).

Piping. Moving water forms subsurface tunnels or pipelike cavities in the soil.

Poor outlets. Surface or subsurface drainage outlets difficult or expensive to install.

Profile, soil. A vertical section of the soil extending through all its horizons and into the parent material.

Reaction, soil. The degree of acidity or alkalinity of a soil, expressed in pH values. A soil that tests to pH 7.0 is described as precisely neutral in reaction because it is neither acid nor alkaline. The degree of acidity or alkalinity is expressed as—

	pH		*pH*
Extremely acid	Below 4.5	Neutral	6.6 to 7.3
Very strongly acid	4.5 to 5.0	Mildly alkaline	7.4 to 7.8
Strongly acid	5.1 to 5.5	Moderately alkaline	7.9 to 8.4
Medium acid	5.6 to 6.0	Strongly alkaline	8.5 to 9.0
Slightly acid	6.1 to 6.5	Very strongly alkaline	9.1 and higher

Relief. The elevations or inequalities of a land surface, considered collectively.

Saline-alkali soil. A soil that contains a harmful concentration of salts and exchangeable sodium; contains harmful salts and is strongly alkaline; or contains harmful salts and exchangeable sodium and is very strongly alkaline. The salts, exchangeable sodium, and alkaline reaction are in the soil in such location that growth of most crop plants is less than normal.

Saline soil. A soil containing soluble salts in an amount that impairs growth of plants. A saline soil does not contain excess exchangeable sodium.

Sand. As a soil separate, individual rock or mineral fragments from 0.05 millimeter to 2.0 millimeters in diameter. Most sand grains consist of quartz. As a soil textural class, a soil that is 85 percent or more sand and not more than 10 percent clay.

Seepage. The rapid movement of water through the soil. Seepage adversely affects the specified use.

Shrink-swell. The shrinking of soil when dry and the swelling when wet. Shrinking and swelling can damage roads, dams, building foundations, and other structures. It can also damage plant roots.

Silt. As a soil separate, individual mineral particles that range in diameter from the upper limit of clay (0.002 millimeter) to the lower limit of very fine sand (0.05 millimeter). As a soil textural class, soil that is 80 percent or more silt and less than 12 percent clay.

Solum. The upper part of a soil profile, above the C horizon, in which the processes of soil formation are active. The solum in mature soil consists of the A and B horizons. Generally, the characteristics of the material in these horizons are unlike those of the underlying material. The living roots and other plant and animal life characteristics of the soil are largely confined to the solum.

Stone line. A concentration of coarse fragments in soils that generally marks an old weathering surface. In a cross section, the line may be one fragment or more thick. The line generally overlies material that weathered in place and marks the top of a paleosol. It is ordinarily overlain by recent sediment of variable thickness.

Stripcropping. Growing crops in a systematic arrangement of strips or bands which provide vegetative barriers to wind and water erosion.

Structure, soil. The arrangement of primary soil particles into compound particles or aggregates that are separated from adjoining aggregates. The principal forms of soil structure are—platy (laminated), prismatic (vertical axis of aggregates longer than horizontal), columnar (prisms with rounded tops), blocky (angular or subangular), and granular. Structureless soils are either single grained (each grain by itself, as in dune sand) or massive (the particles adhering without any regular cleavage, as in many hardpans).

Stubble mulch. Stubble or other crop residue left on the soil, or partly worked into the soil, to provide protection from soil blowing and water erosion after harvest, during preparation of a seedbed for the next crop, and during the early growing period of the new crop.

Subsoil. Technically, the B horizon; roughly, the part of the solum below plow depth.

Substratum. The part of the soil below the solum.

Summer fallow. The tillage of uncropped land during the summer to control weeds and allow storage of moisture in the soil for the growth of a later crop. A practice common in semiarid regions, where annual precipitation is not enough to produce a crop every year. Summer fallow is frequently practiced before planting winter grain.

Surface layer. A term used in nontechnical soil descriptions for one or more layers above the subsoil. Includes A horizon and part of B horizon; has no depth limit.

Surface soil. The soil ordinarily moved in tillage, or its equivalent in uncultivated soil, ranging in depth from 4 to 10 inches (10 to 25 centimeters). Frequently designated as the "plow layer," or the "Ap horizon."

Texture, soil. The relative proportions of sand, silt, and clay particles in a mass of soil. The basic textural classes, in order of increasing proportion of fine particles, are sand, loamy sand, sandy loam, loam, silt, silt loam, sandy clay loam, clay loam, silty clay loam, sandy clay, silty clay, and clay. The sand, loamy sand, and sandy loam classes may be further divided by specifying "coarse," "fine," or "very fine."

Thin layer. Otherwise suitable soil material too thin for the specified use.

Tilth, soil. The condition of the soil, especially the soil structure, as related to the growth of plants. Good tilth refers to the friable state and is associated with high noncapillary porosity and stable structure. A soil in poor tilth is nonfriable, hard, nonaggregated, and difficult to till.

Water table. The upper limit of the soil or underlying rock material that is wholly saturated with water.

Water table, apparent. A thick zone of free water in the soil. An apparent water table is indicated by the level at which water stands in an uncased borehole after adequate time is allowed for adjustment in the surrounding soil.

Water table, artesian. A water table under hydrostatic head, generally beneath an impermeable layer. When this layer is penetrated, the water level rises in an uncased borehole.

Water table, perched. A water table standing above an unsaturated zone. In places an upper, or perched, water table is separated from a lower one by a dry zone.

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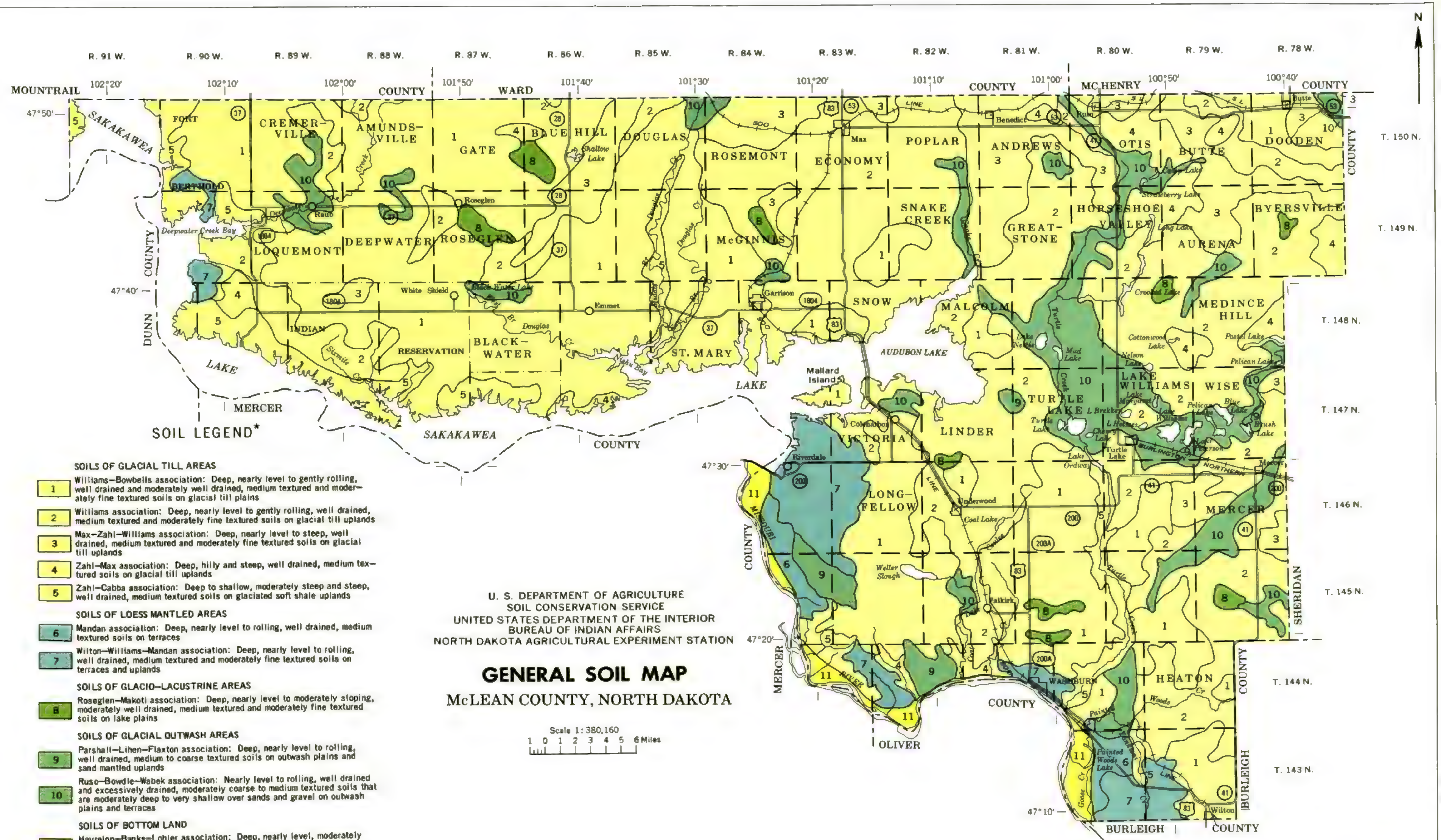


SOIL LEGEND*

SOILS OF GLACIAL TILL AREAS

1 Williams–Bowbells association: Deep, nearly level to gently rolling, well drained and moderately well drained, medium textured and moderately fine textured soils on glacial till plains

2 Williams association: Deep, nearly level to gently rolling, well drained, medium textured and moderately fine textured soils on glacial till uplands

3 Max–Zahl–Williams association: Deep, nearly level to steep, well drained, medium textured and moderately fine textured soils on glacial till uplands

4 Zahl–Max association: Deep, hilly and steep, well drained, medium textured soils on glacial till uplands

5 Zahl–Cabba association: Deep to shallow, moderately steep and steep, well drained, medium textured soils on glaciated soft shale uplands

SOILS OF LOESS MANTLED AREAS

6 Mandan association: Deep, nearly level to rolling, well drained, medium textured soils on terraces

7 Wilton–Williams–Mandan association: Deep, nearly level to rolling, well drained, medium textured and moderately fine textured soils on terraces and uplands

SOILS OF GLACIO–LACUSTRINE AREAS

8 Roseglen–Makoti association: Deep, nearly level to moderately sloping, moderately well drained, medium textured and moderately fine textured soils on lake plains

SOILS OF GLACIAL OUTWASH AREAS

9 Parshall–Lihen–Flaxton association: Deep, nearly level to rolling, well drained, medium to coarse textured soils on outwash plains and sand mantled uplands

10 Ruso–Bowdle–Wabek association: Nearly level to rolling, well drained and excessively drained, moderately coarse to medium textured soils that are moderately deep to very shallow over sands and gravel on outwash plains and terraces

SOILS OF BOTTOM LAND

11 Havrelon–Banks–Lohler association: Deep, nearly level, moderately well drained to somewhat excessively drained, fine to medium textured and coarse textured soils on bottom land

* Texture given in descriptive title refers to texture of the surface layer.

Compiled 1978

Each area outlined on this map consists of more than one kind of soil. The map is thus meant for general planning rather than a basis for decisions on the use of specific tracts.

U. S. DEPARTMENT OF AGRICULTURE
SOIL CONSERVATION SERVICE
UNITED STATES DEPARTMENT OF THE INTERIOR
BUREAU OF INDIAN AFFAIRS
NORTH DAKOTA AGRICULTURAL EXPERIMENT STATION

GENERAL SOIL MAP

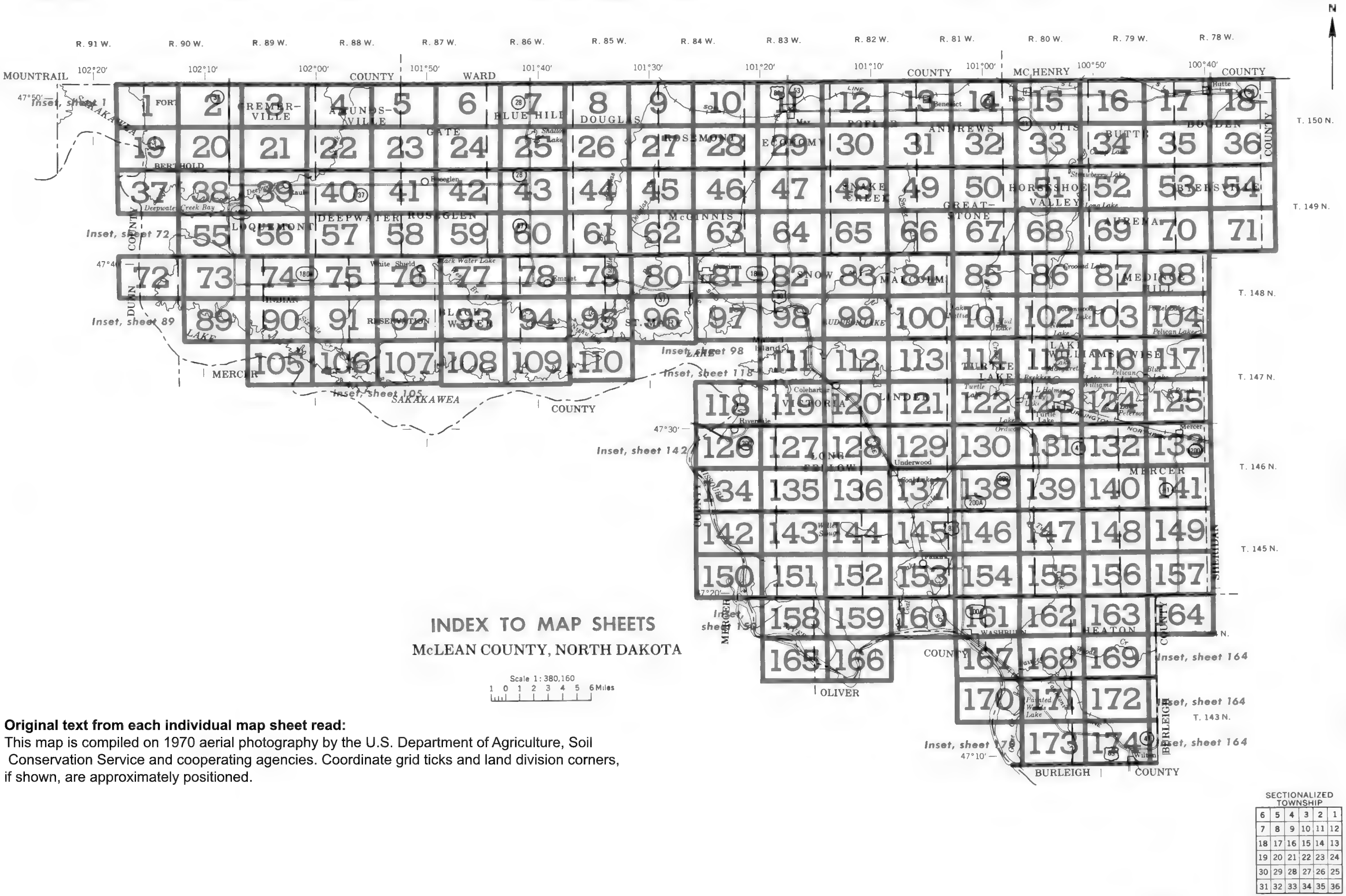
McLEAN COUNTY, NORTH DAKOTA

Scale 1: 380,160

1 0 1 2 3 4 5 6 Miles

SECTIONALIZED TOWNSHIP

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36



INDEX TO MAP SHEETS

McLEAN COUNTY, NORTH DAKOTA

Original text from each individual map sheet read:

This map is compiled on 1970 aerial photography by the U.S. Department of Agriculture, Soil Conservation Service and cooperating agencies. Coordinate grid ticks and land division corners, if shown, are approximately positioned.

SOIL LEGEND

The first capital letter is the initial one of the soil name. The lower case letter that follows separates mapping units having names that begin with the same letter except that it does not separate slope phases. A second capital letter A, B, C, D, E, or F shows the slope. Symbols without a slope letter are for soils that are nearly level or a miscellaneous land type.

SYMBOL	NAME	SYMBOL	NAME
Ac	Aquents	MhC	Max–Bowbells–Zahl loams, 6 to 9 percent slopes
Af	Aquolls	MlC	Max–Zahl loams, 6 to 9 percent slopes
ArA	Arnegard loam, 1 to 3 percent slopes	MlD	Max–Zahl loams, 9 to 15 percent slopes
ArB	Arnegard loam, 3 to 6 percent slopes	MoC	Morton loam, 3 to 9 percent slopes
ArC	Arnegard loam, 6 to 9 percent slopes	NbA	Niobell–Williams loams, 1 to 3 percent slopes
Ba	Banks loamy fine sand	NbB	Niobell–Williams loams, 3 to 6 percent slopes
Bk	Banks loam	NmB	Noonan–Miranda complex, 1 to 6 percent slopes
BoA	Bowbells loam, 1 to 3 percent slopes	NmD	Noonan–Miranda complex, 6 to 15 percent slopes
BsB	Bowbells–Williams loams, 3 to 6 percent slopes	NtA	Nutley silty clay, 1 to 3 percent slopes
BwA	Bowdle loam, 1 to 3 percent slopes	NtB	Nutley silty clay, 3 to 6 percent slopes
ByB	Bowdle–Stady loams, 3 to 6 percent slopes	Or	Orthents, loamy
ByC	Bowdle–Stady loams, 6 to 9 percent slopes	Pa	Parnell silty clay loam
CaE	Cabba complex, 15 to 35 percent slopes	Pe	Parnell silty clay loam, very wet
CbF	Cabba–Shale outcrop complex, 25 to 60 percent slopes	PhA	Parshall fine sandy loam, 1 to 3 percent slopes
ChD	Cohagen–Vebar complex, 9 to 15 percent slopes	PhB	Parshall fine sandy loam, 3 to 6 percent slopes
ChE	Cohagen–Vebar complex, 15 to 35 percent slopes	PhC	Parshall fine sandy loam, 6 to 9 percent slopes
Co	Colvin silty clay loam	PhD	Parshall fine sandy loam, 9 to 15 percent slopes
Dm	Dimmick clay	PoA	Parshall loam, 1 to 3 percent slopes
Dv	Divide loam	PoB	Parshall loam, 3 to 6 percent slopes
FaA	Falkirk loam, 1 to 3 percent slopes	RgC	Regent silty clay loam, 3 to 9 percent slopes
FaB	Falkirk loam, 3 to 6 percent slopes	RhB	Rhoades complex, 1 to 9 percent slopes
FbA	Falkirk and Max loams, 1 to 3 percent slopes	Rm	Riverwash
FbB	Falkirk and Max loams, 3 to 6 percent slopes	Ro	Roseglen silt loam
FbC	Falkirk and Max loams, 6 to 9 percent slopes	RpB	Roseglen–Tansem complex, 3 to 6 percent slopes
FfA	Farnuf loam, 1 to 3 percent slopes	RpC	Roseglen–Tansem complex, 6 to 9 percent slopes
FfB	Farnuf loam, 3 to 6 percent slopes	RsA	Ruso coarse sandy loam, 1 to 3 percent slopes
FlD	Flasher fine sandy loam, 6 to 15 percent slopes	RtB	Ruso–Manning coarse sandy loams, 3 to 6 percent slopes
FlE	Flasher fine sandy loam, 15 to 35 percent slopes	RtC	Ruso–Manning coarse sandy loams, 6 to 9 percent slopes
FnA	Flaxton fine sandy loam, 1 to 3 percent slopes	RxB	Ruso–Manning complex, 3 to 6 percent slopes
FnB	Flaxton fine sandy loam, 3 to 6 percent slopes	RyC	Ruso–Wabek complex, 6 to 9 percent slopes
FnC	Flaxton fine sandy loam, 6 to 9 percent slopes	RzA	Ruso soils, 1 to 3 percent slopes
Fs	Fossum fine sandy loam	SeD	Seroco fine sand, 9 to 25 percent slopes
GaA	Grail silty clay loam, 1 to 3 percent slopes	Sn	Sinai silty clay
GaB	Grail silty clay loam, 3 to 6 percent slopes	St	Straw loam
Gn	Grano silty clay	Sx	Straw soils, channeled
GoA	Grassna silt loam, 1 to 3 percent slopes	TlC	Telfer–Lihen loamy fine sands, 3 to 9 percent slopes
HaA	Hamerly loam, 1 to 3 percent slopes	Tp	Tonka–Parnell complex
Hk	Harriet–Saline land complex	Tr	Trembles fine sandy loam
Hn	Havrelon very fine sandy loam	VwC	Vebar–Williams fine sandy loams, 3 to 9 percent slopes
Ho	Havrelon silty clay loam	WaB	Wabek–Max–Zahl loams, 1 to 6 percent slopes
Hs	Heil silty clay loam	WaD	Wabek–Max–Zahl loams, 6 to 15 percent slopes
KrB	Krem loamy fine sand, 1 to 6 percent slopes	WbB	Wabek soils, 1 to 6 percent slopes
La	Lallie soils	WbD	Wabek soils, 6 to 15 percent slopes
LeB	Lihen loamy fine sand, 1 to 6 percent slopes	WlB	Williams stony loam, 1 to 9 percent slopes
LeC	Lihen loamy fine sand, 6 to 9 percent slopes	WmA	Williams clay loam, 1 to 3 percent slopes
LgE	Lihen–Zahl complex, 9 to 25 percent slopes	WmB	Williams clay loam, 3 to 6 percent slopes
LmB	Linton–Mandan silt loams, 3 to 6 percent slopes	WoA	Williams–Bowbells loams, 1 to 3 percent slopes
LmC	Linton–Mandan silt loams, 6 to 9 percent slopes	WoB	Williams–Bowbells loams, 3 to 6 percent slopes
LmD	Linton–Mandan silt loams, 9 to 15 percent slopes	WoC	Williams–Bowbells loams, 6 to 9 percent slopes
LmE	Linton–Mandan silt loams, 15 to 40 percent slopes	WpB	Williams–Bowbells–Zahl loams, 3 to 6 percent slopes
Lw	Lohler silty clay loam	WrB	Williams loam, mine sink, 1 to 6 percent slopes
Ly	Lohler silty clay	WsA	Wilton silt loam, 1 to 3 percent slopes
Ma	Makoti silty clay loam	WtB	Wilton–Temvik silt loams, 3 to 6 percent slopes
MdA	Mandan silt loam, 1 to 3 percent slopes	WwC	Wilton–Williams silt loams, 6 to 9 percent slopes
MdB	Mandan silt loam, 3 to 6 percent slopes	ZcE	Zahl–Cabba complex, 15 to 35 percent slopes
MdC	Mandan silt loam, 6 to 9 percent slopes	ZmE	Zahl–Max loams, 9 to 35 percent slopes
Mf	Marysland loam	ZpE	Zahl–Max–Parnell complex, 15 to 35 percent slopes
MgB	Max loam, 3 to 6 percent slopes	ZwC	Zahl–Williams loams, 3 to 9 percent slopes

CONVENTIONAL AND SPECIAL SYMBOLS LEGEND

CULTURAL FEATURES

BOUNDARIES

- National, state or province
- County or parish
- Minor civil division
- Reservation (national forest or park, state forest or park, and large airport)
- Land grant
- Limit of soil survey (label)
- Field sheet matchline & neatline

AD HOC BOUNDARY (label)

- Small airport, airfield, park, oilfield, cemetery, or flood pool — Davis Airstrip; FLOOD POOL LINE

STATE COORDINATE TICK

LAND DIVISION CORNERS (sections and land grants)

ROADS

- Divided (median shown if scale permits)
- Other roads
- Trail

ROAD EMBLEMS & DESIGNATIONS

- Interstate — 79
- Federal — 410
- State — 52
- County, farm or ranch — 378

RAILROAD

POWER TRANSMISSION LINE (normally not shown)

PIPE LINE (normally not shown)

FENCE (normally not shown)

LEVEES

- Without road
- With road
- With railroad

DAMS

- Large (to scale)
- Medium or small — water; w

PITS

- Gravel pit
- Mine or quarry

MISCELLANEOUS CULTURAL FEATURES

- Farmstead, house (omit in urban areas)
- Church
- School
- Indian mound (label) — Indian Mound
- Located object (label) — Tower
- Tank (label) — GAS
- Wells, oil or gas
- Windmill
- Kitchen midden

WATER FEATURES

DRAINAGE

- Perennial, double line
- Perennial, single line
- Intermittent
- Drainage end
- Canals or ditches
  - Double-line (label) — CANAL
  - Drainage and/or irrigation

LAKES, PONDS AND RESERVOIRS

- Perennial — water; w
- Intermittent — int; i

MISCELLANEOUS WATER FEATURES

- Marsh or swamp
- Spring
- Well, artesian
- Well, irrigation
- Wet spot

SPECIAL SYMBOLS FOR SOIL SURVEY

SOIL DELINEATIONS AND SYMBOLS — CeA; FoB2

ESCARPMENTS

- Bedrock (points down slope)
- Other than bedrock (points down slope)

SHORT STEEP SLOPE

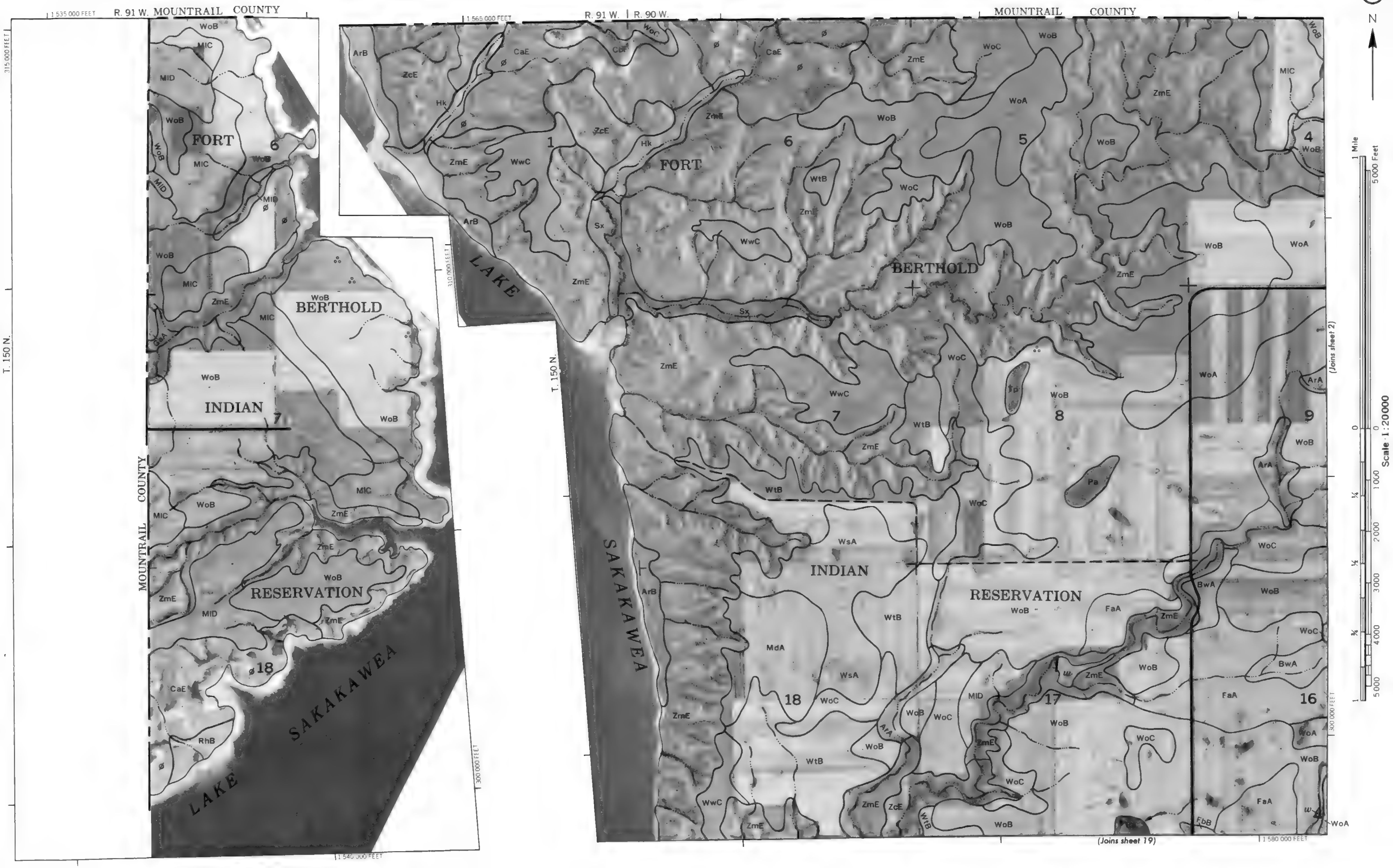
GULLY

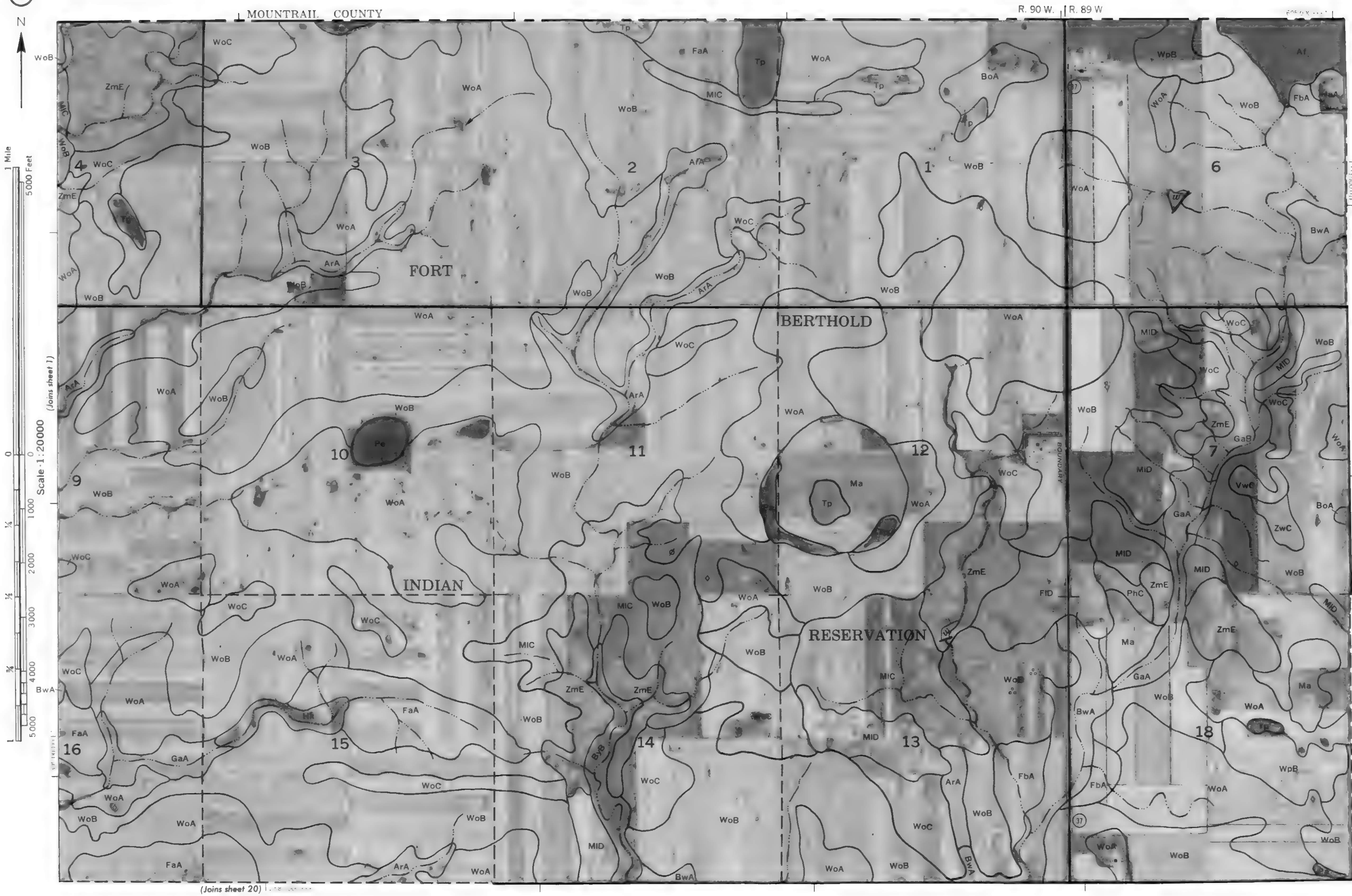
DEPRESSION OR SINK

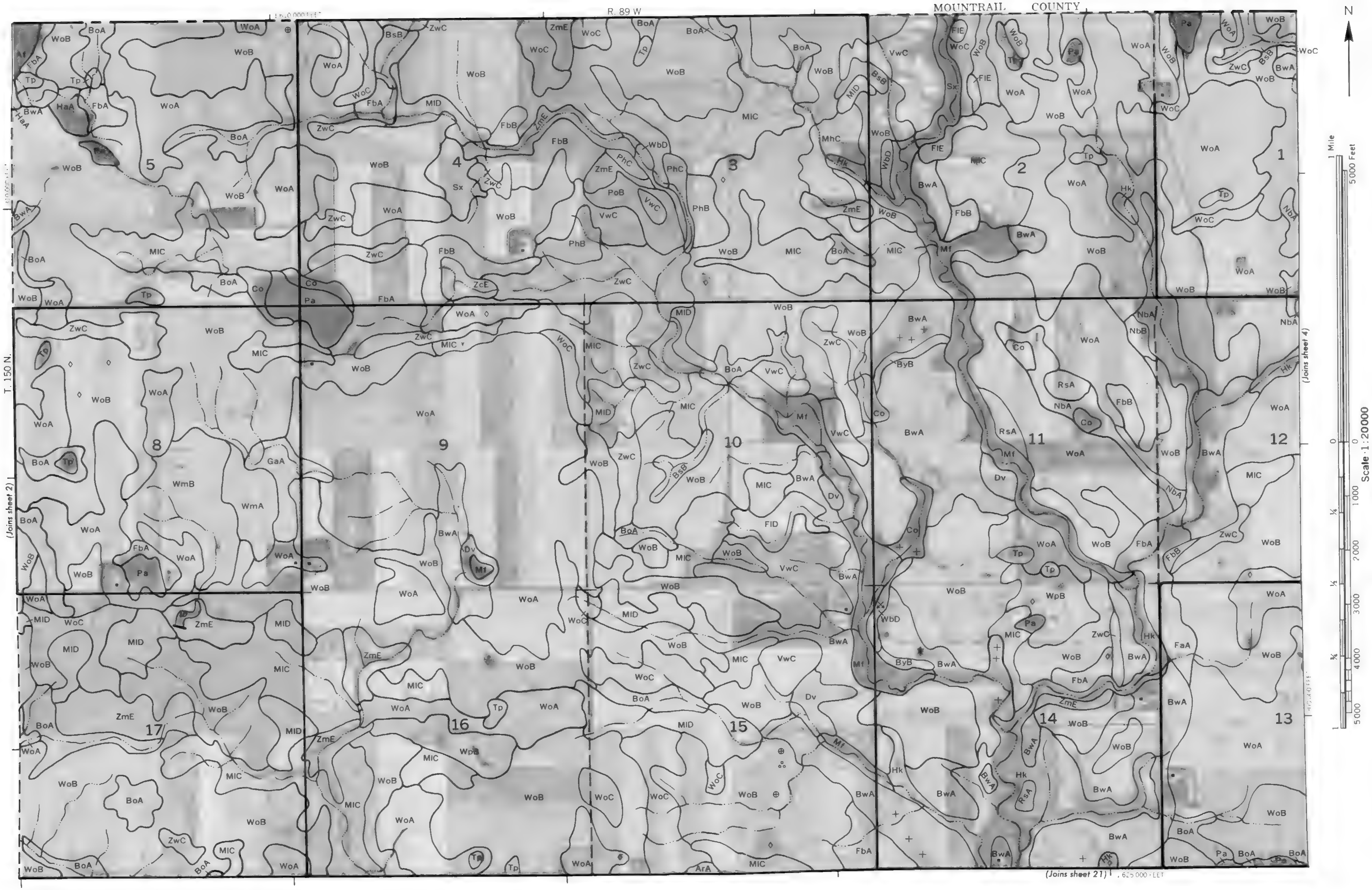
SOIL SAMPLE SITE (normally not shown) — S

MISCELLANEOUS

- Blowout
- Clay spot
- Gravelly spot
- Gumbo, slick or scabby spot (sodic)
- Dumps and other similar non soil areas
- Prominent hill or peak
- Rock outcrop (includes sandstone and shale)
- Saline spot
- Sandy spot
- Severely eroded spot
- Slide or slip (tips point upslope)
- Stony spot, very stony spot
- Spot of Zahl soil up to 2 acres in size
- Spot of cut and fill land — C.F

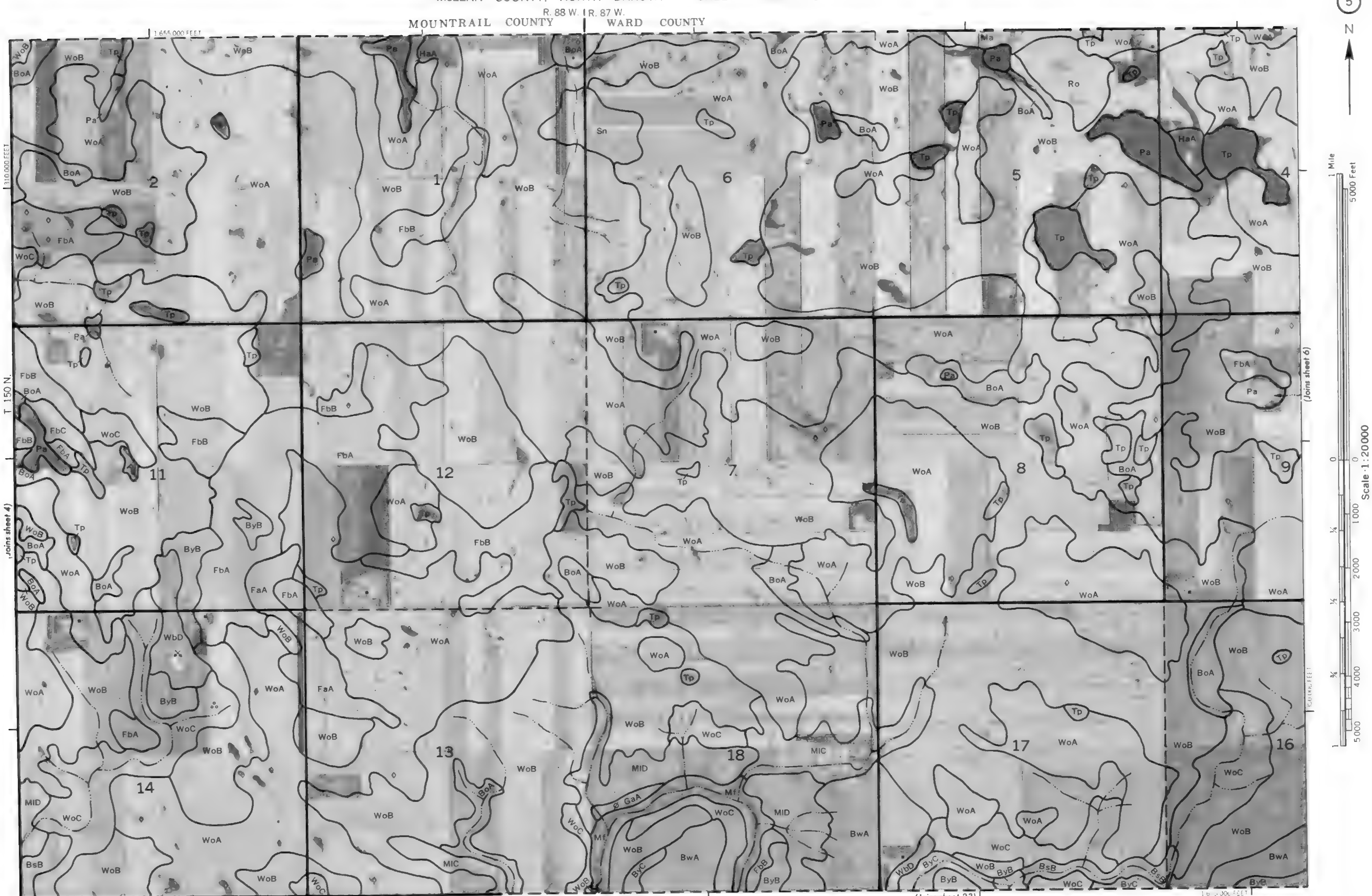

1
N
R. 91 W.
MOUNTRAIL COUNTY
R. 91 W. | R. 90 W.
MOUNTRAIL COUNTY
1 535 000 FEET
1 565 000 FEET
315 000 FEET
310 000 FEET
300 000 FEET
1 540 000 FEET
1 580 000 FEET
T. 150 N.
T. 150 N.
MOUNTRAIL COUNTY
FORT
BERTHOLD
INDIAN
RESERVATION
FORT
BERTHOLD
INDIAN
RESERVATION
LAKE
SAKAKAWEA
LAKE
SAKAKAWEA
(Joins sheet 2)
(Joins sheet 19)
1 Mile
5000 Feet
Scale 1:20000
WoB
MIC
MID
ZmE
CaE
RhB
ArB
ZcE
Hk
WwC
Sx
WtB
WoC
WoA
WsA
MdA
FaA
BwA
ArA
Pa
FbB
1
4
5
6
7
8
9
16
17
18

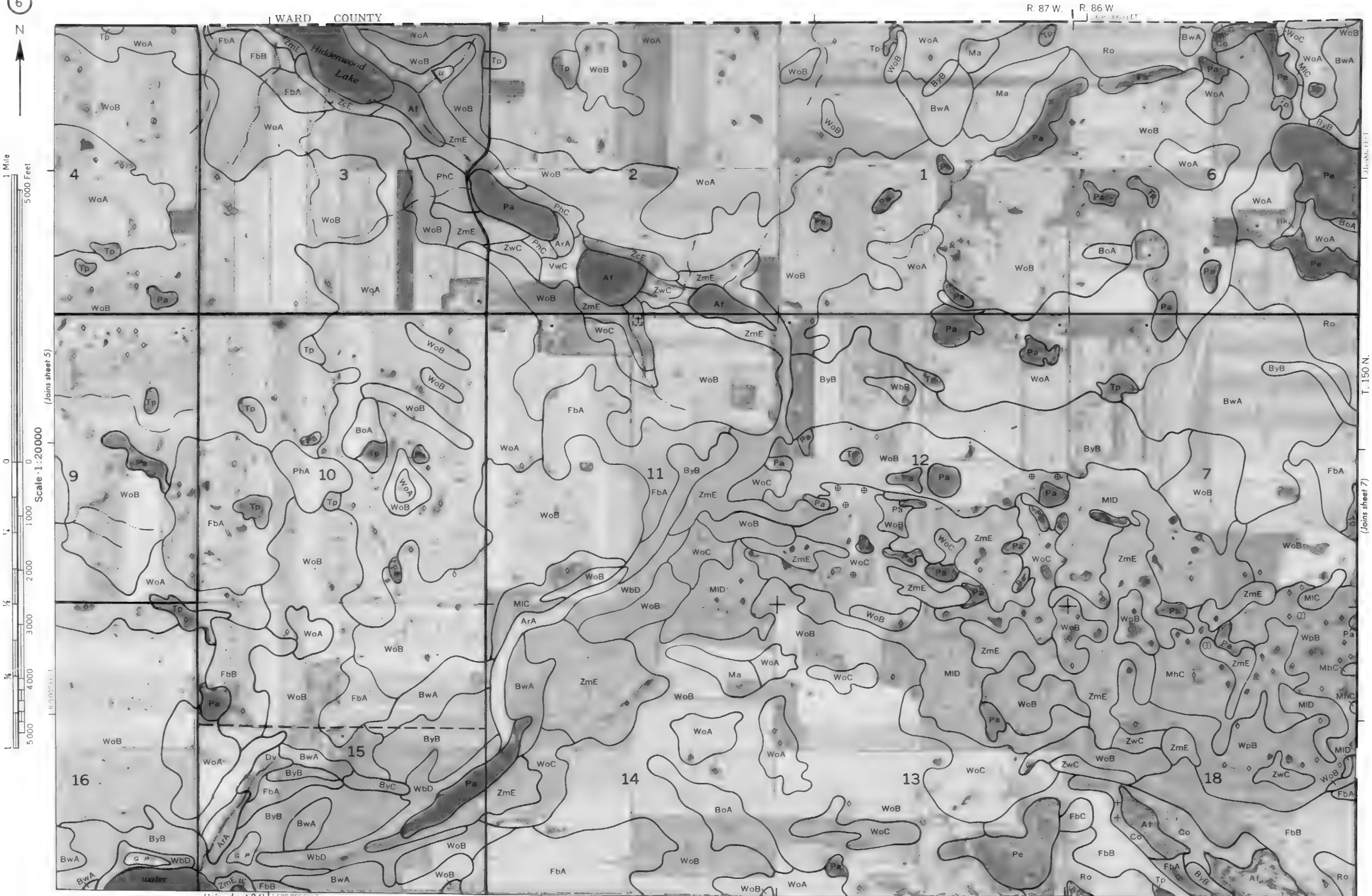

MOUNTRAIL COUNTY
R. 90 W.
R. 89 W.
N
FORT
BERTHOLD
INDIAN
RESERVATION
T. 150 N.
(Joins sheet 1)
(Joins sheet 3)
(Joins sheet 20)
BOUNDARY
Scale 1:20000
1 Mile
5000 Feet
WoA
WoB
WoC
ZmE
ArA
Tp
MIC
MID
FaA
BoA
WpB
Af
FbA
BwA
Pe
Ma
GaA
GaB
PhC
VwC
ZwC
FfD
ByB
Hk


MOUNTRAIL COUNTY
R. 89 W
T. 150 N.
(Joins sheet 2)
(Joins sheet 4)
(Joins sheet 21)
N
1 Mile
5000 Feet
Scale 1:20000
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17


4
MOUNTRAIL COUNTY
R 89 W
R 88 W
T. 150 N.
(Joins sheet 3)
(Joins sheet 5)
(Joins sheet 22)
Scale 1:20000
1 Mile
5000 Feet
water

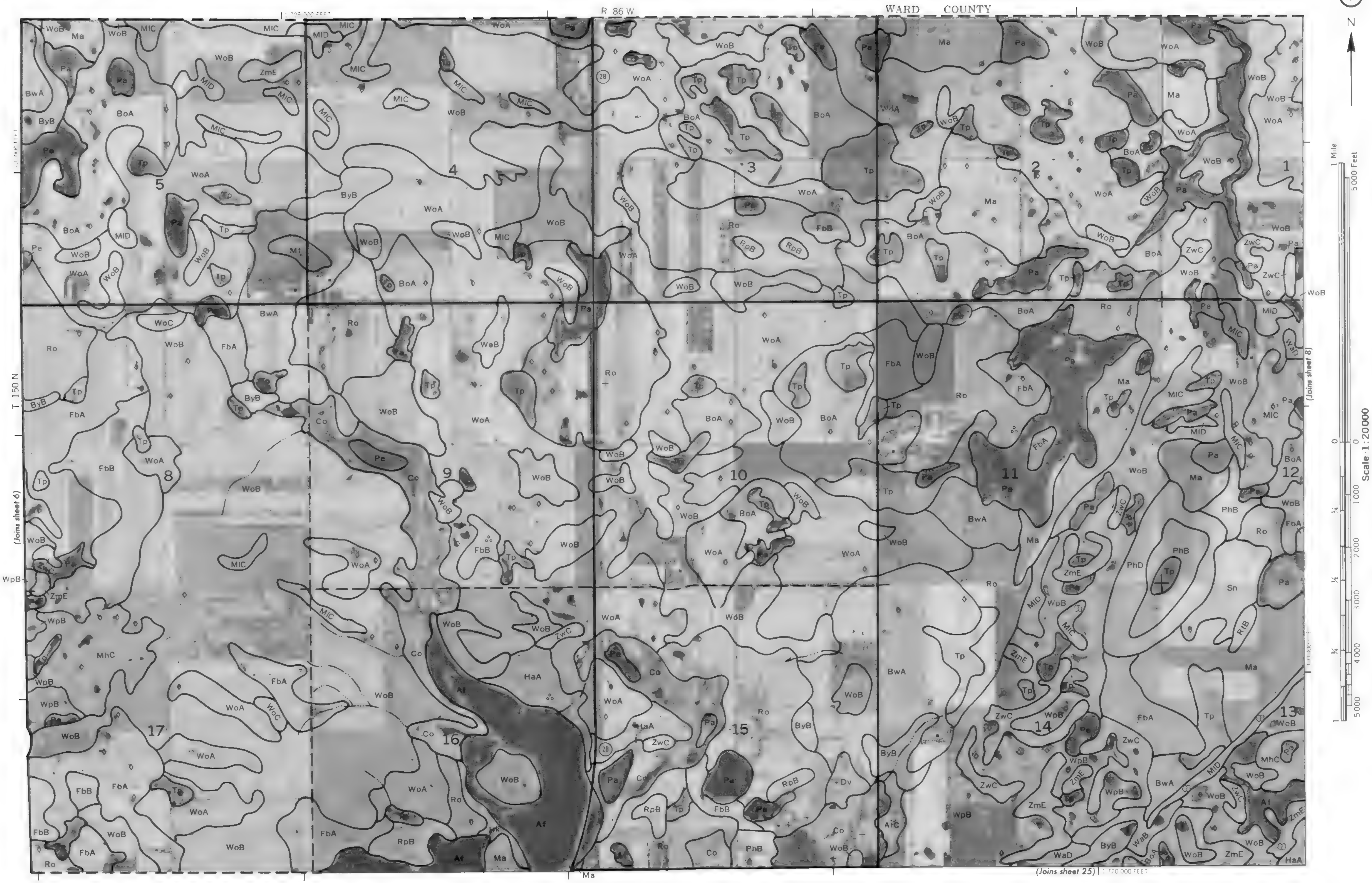
McLEAN COUNTY, NORTH DAKOTA — SHEET NUMBER 5

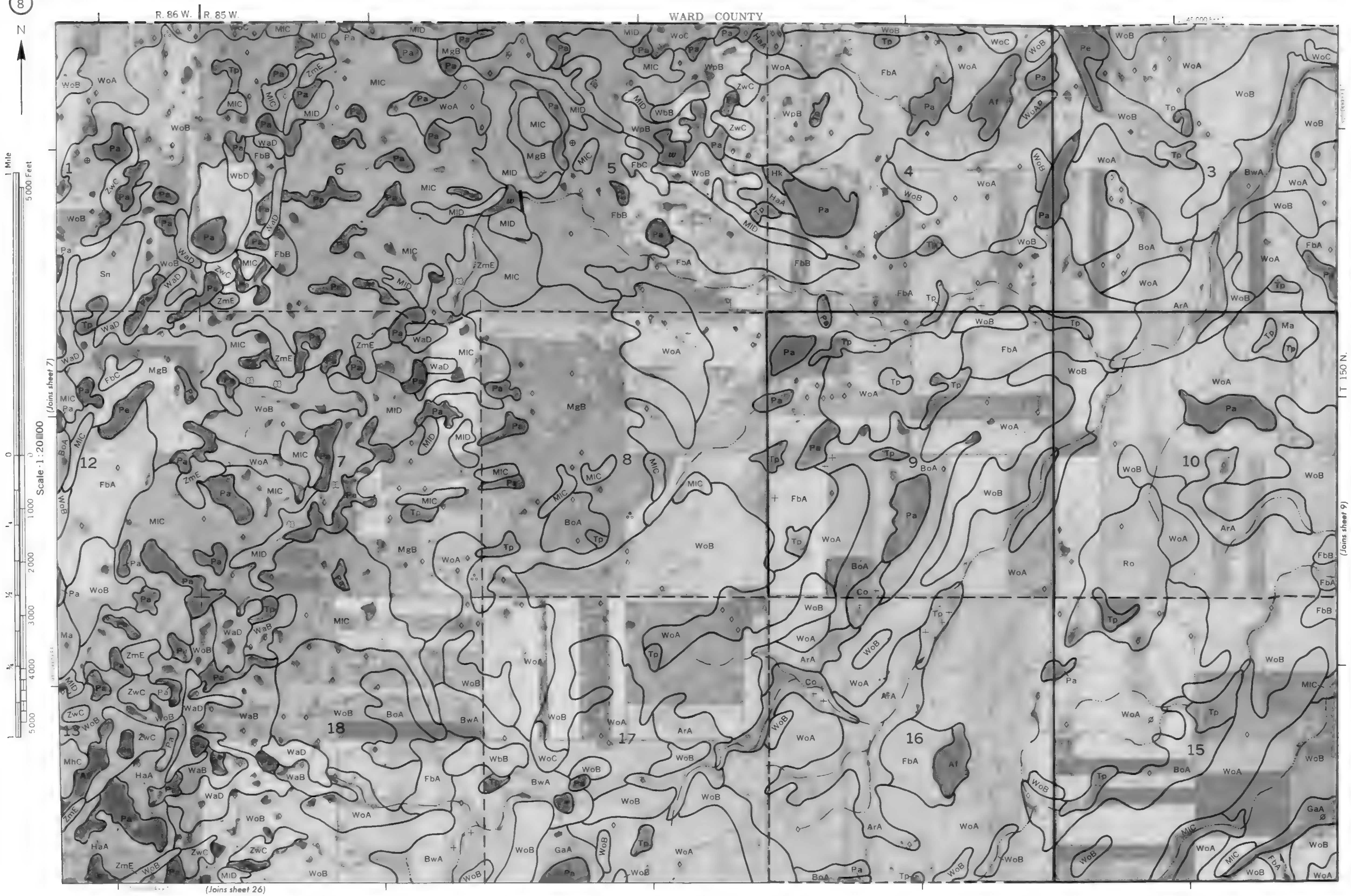


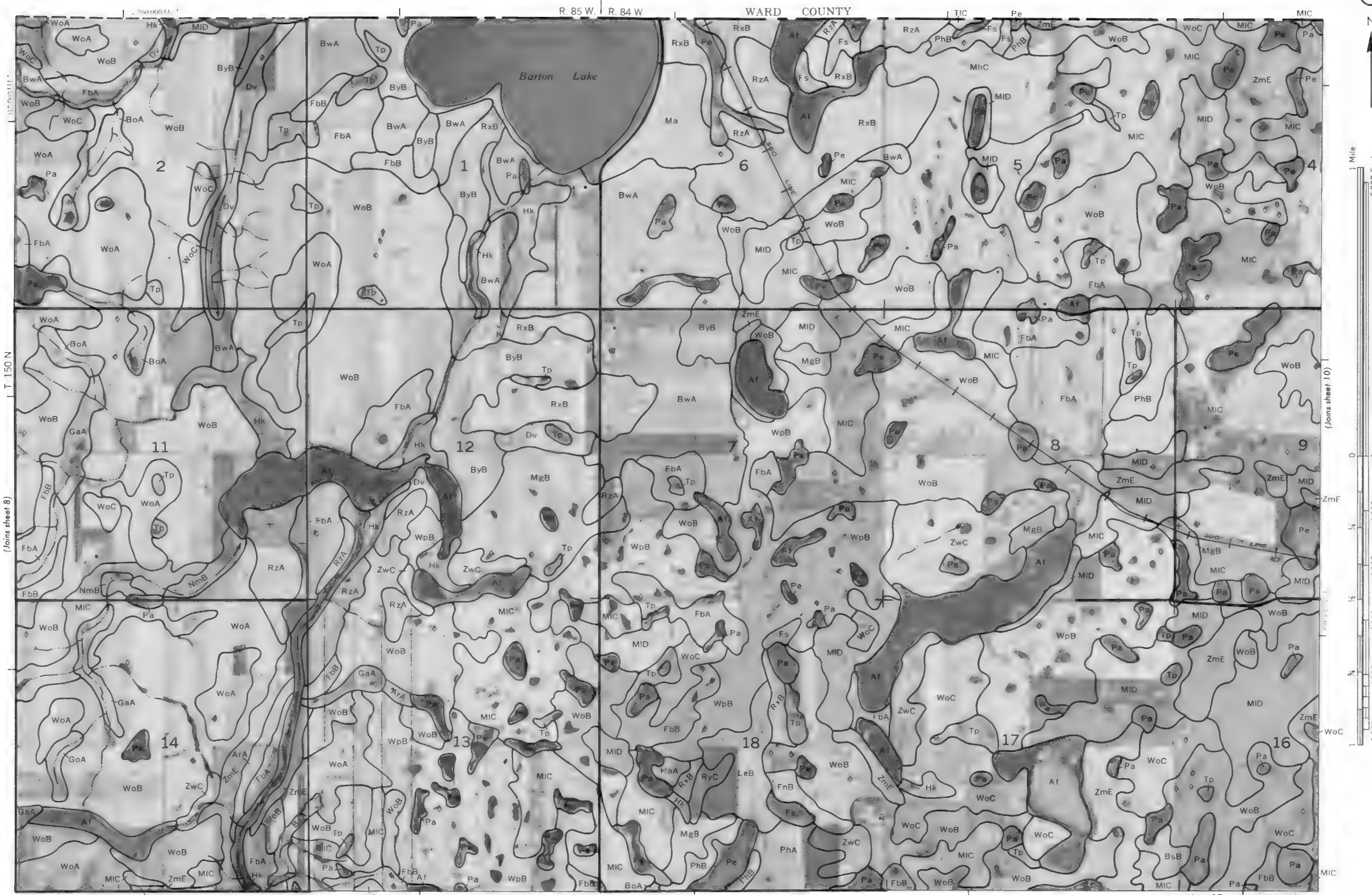

N
WARD COUNTY
Hiddenwood Lake
R. 87 W.
R. 86 W.
T. 150 N.
(Joins sheet 5)
(Joins sheet 7)
(Joins sheet 24)
1 Mile
5000 Feet
Scale 1:20000
water
1
2
3
4
6
7
9
10
11
12
13
14
15
16
18

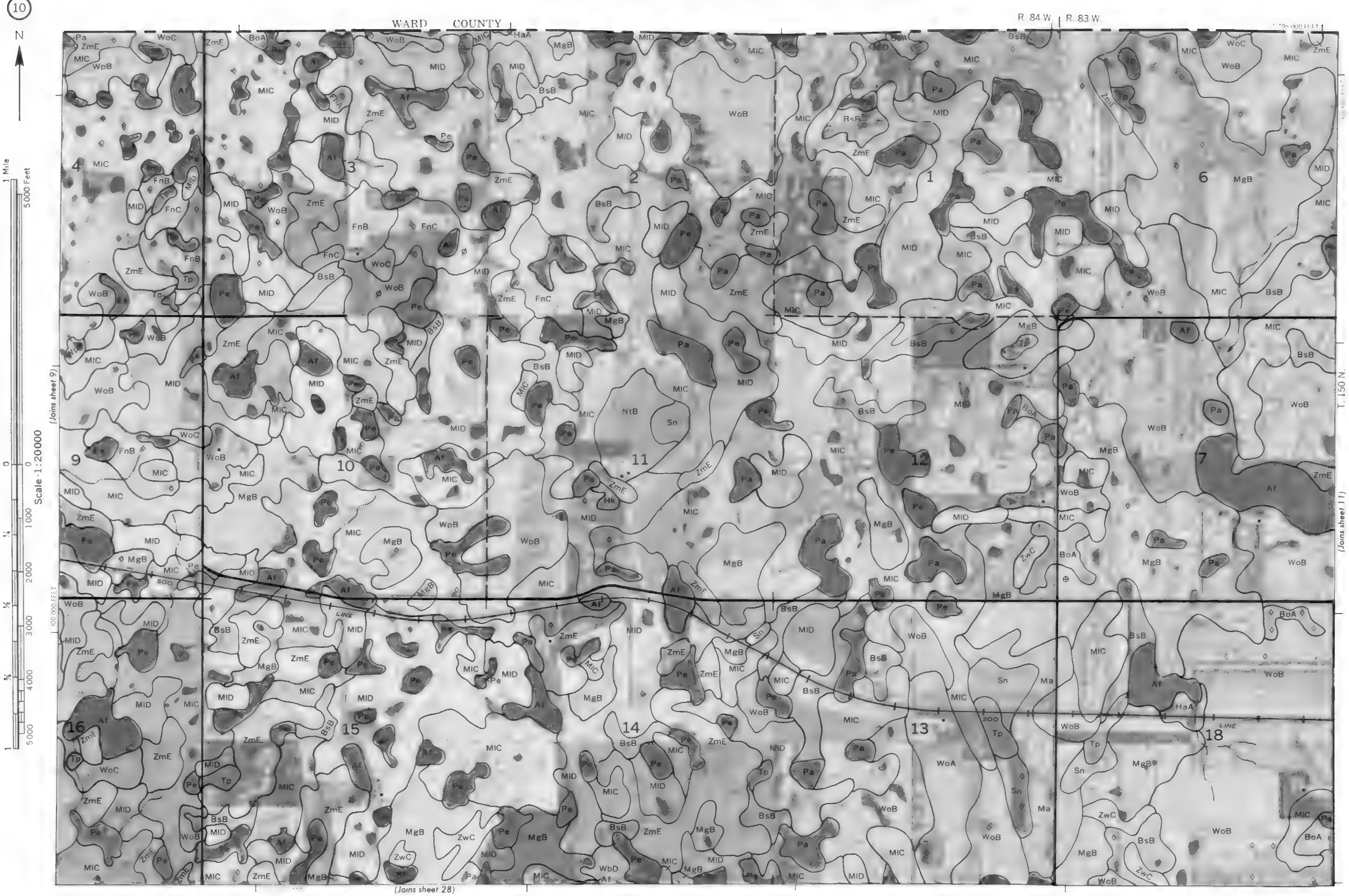
McLEAN COUNTY, NORTH DAKOTA — SHEET NUMBER 7

7

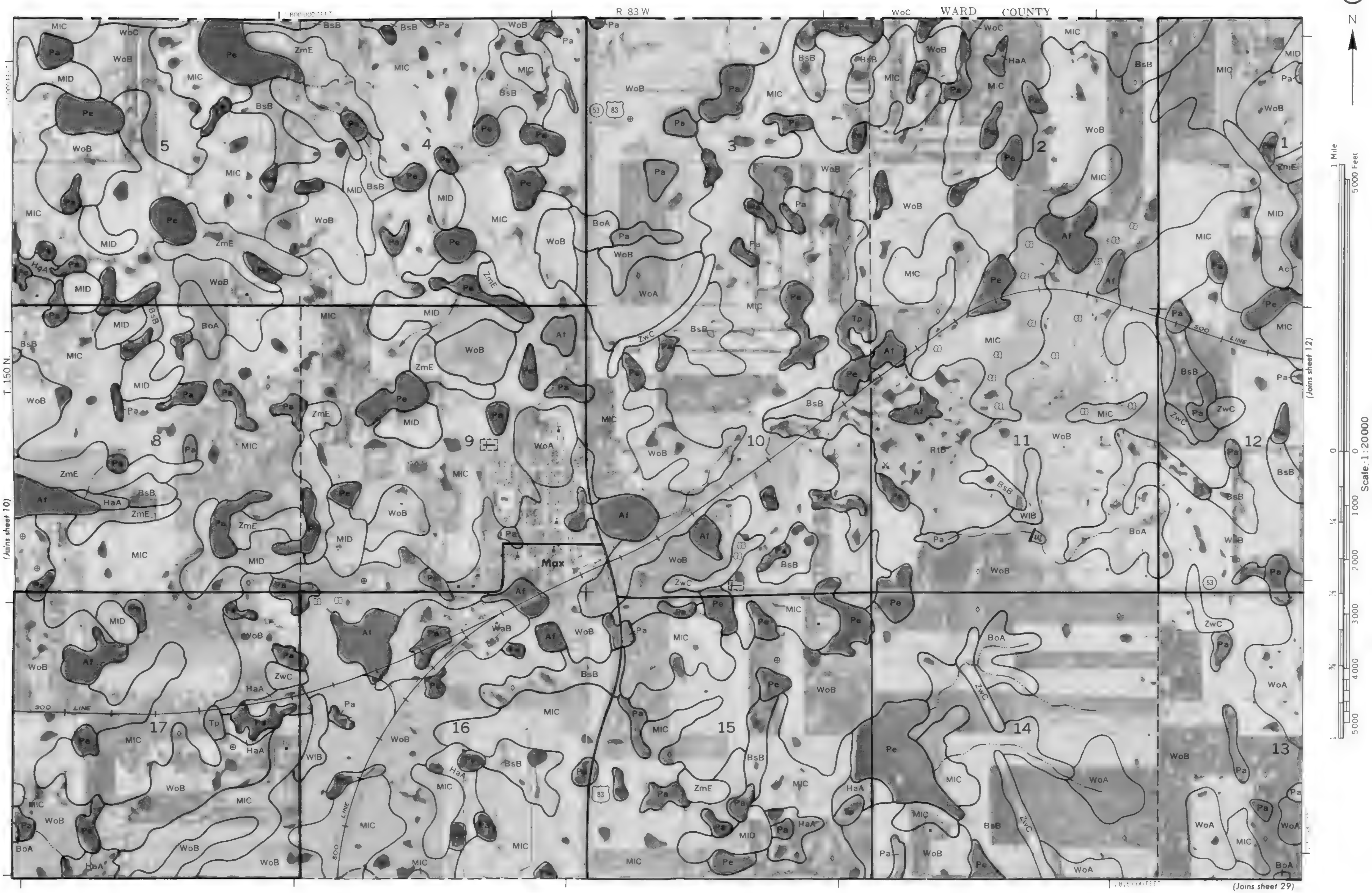


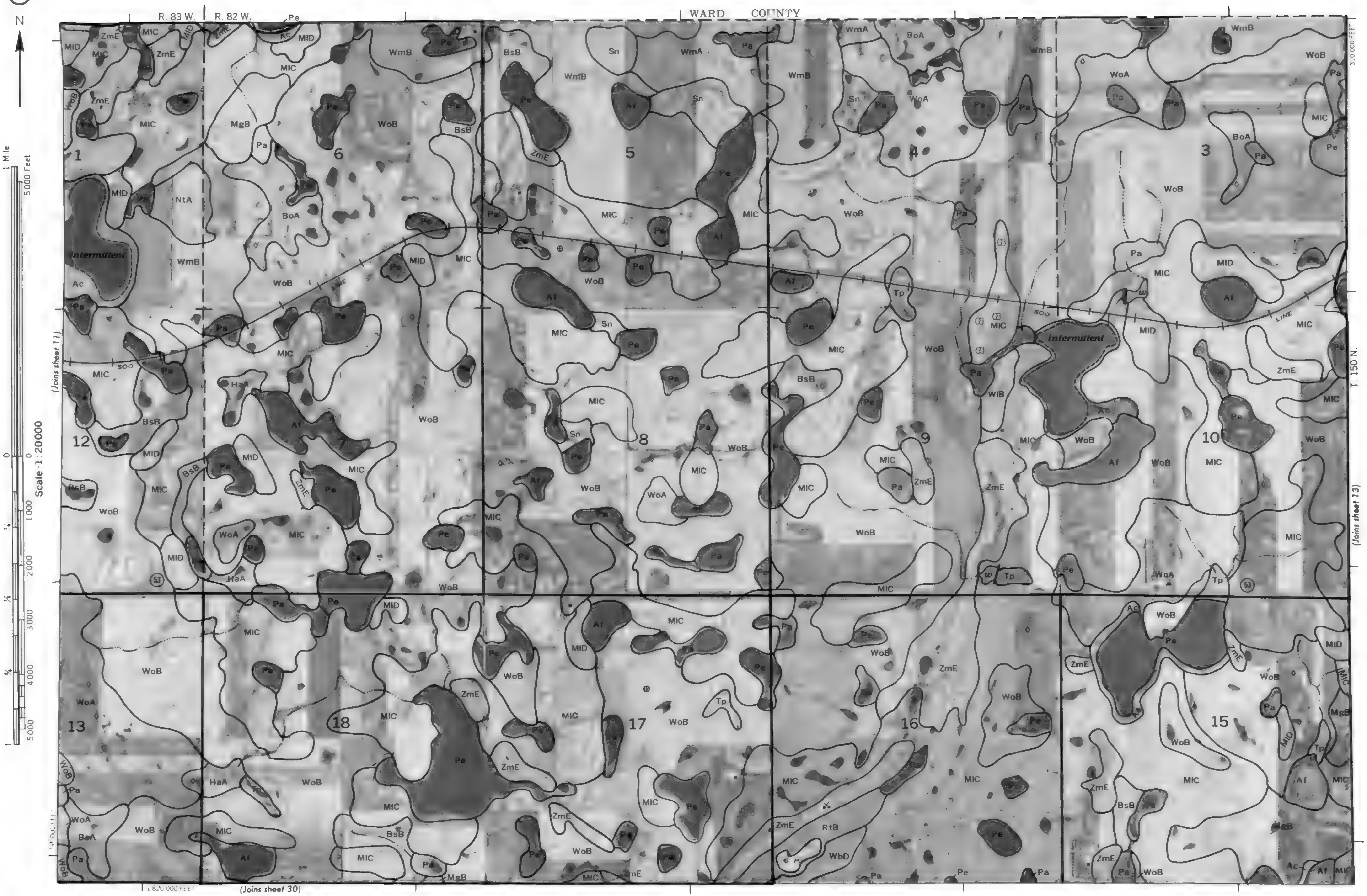

8
N
R. 86 W.
R. 85 W.
WARD COUNTY
(Joins sheet 7)
(Joins sheet 9)
(Joins sheet 26)
T 150 N.
1 Mile
5000 Feet
Scale 1:20 000
0
1000
2000
3000
4000
5000
1
2
3
4
5
6
7
8
9
10
11
12
13
15
16
17
18

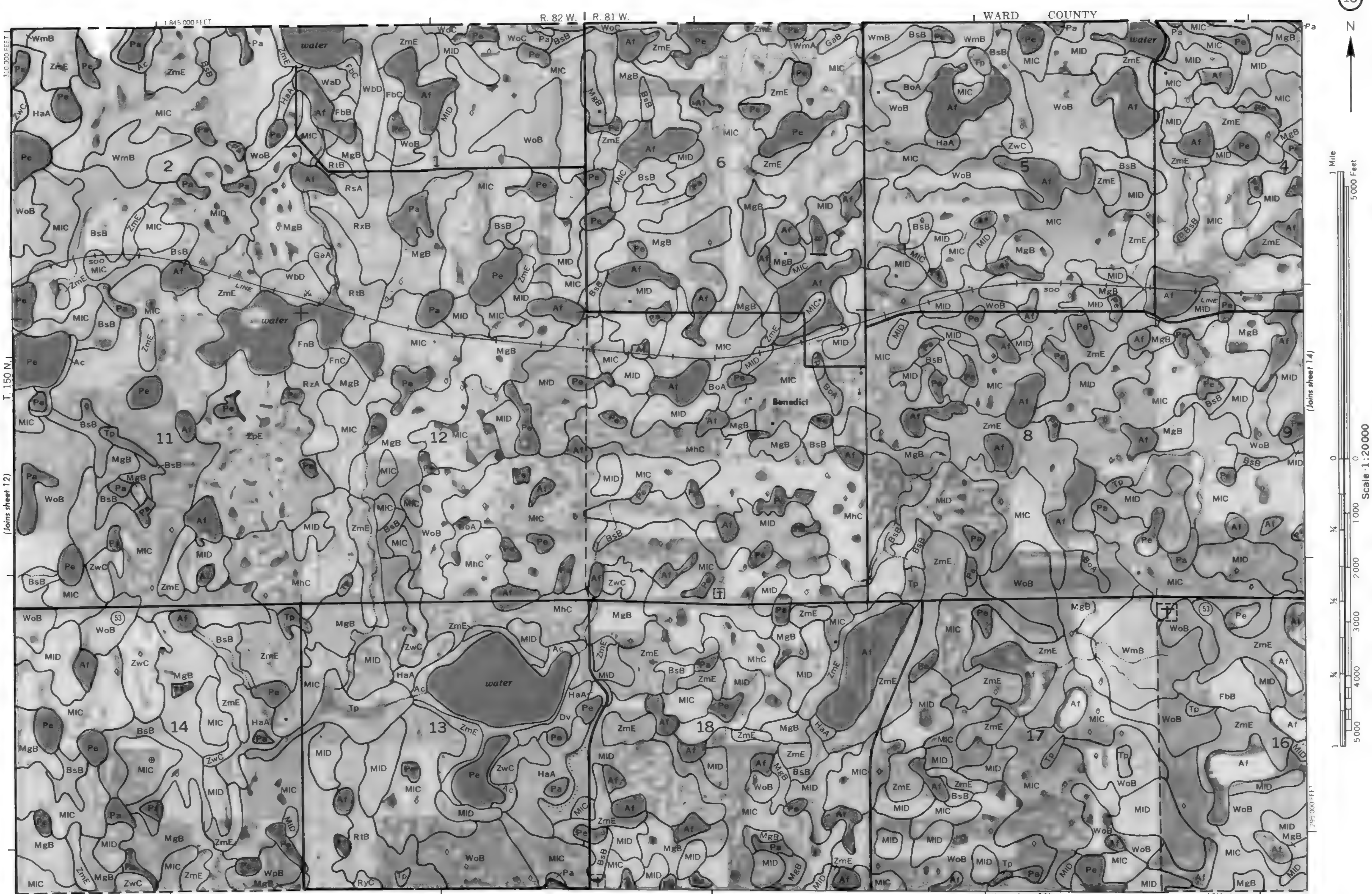

9
N
R. 85 W.
R. 84 W.
WARD COUNTY
Barton Lake
T 150 N
SOO LINE
(Joins sheet 8)
(Joins sheet 10)
(Joins sheet 27)
1 Mile
5000 Feet
Scale 1:20000

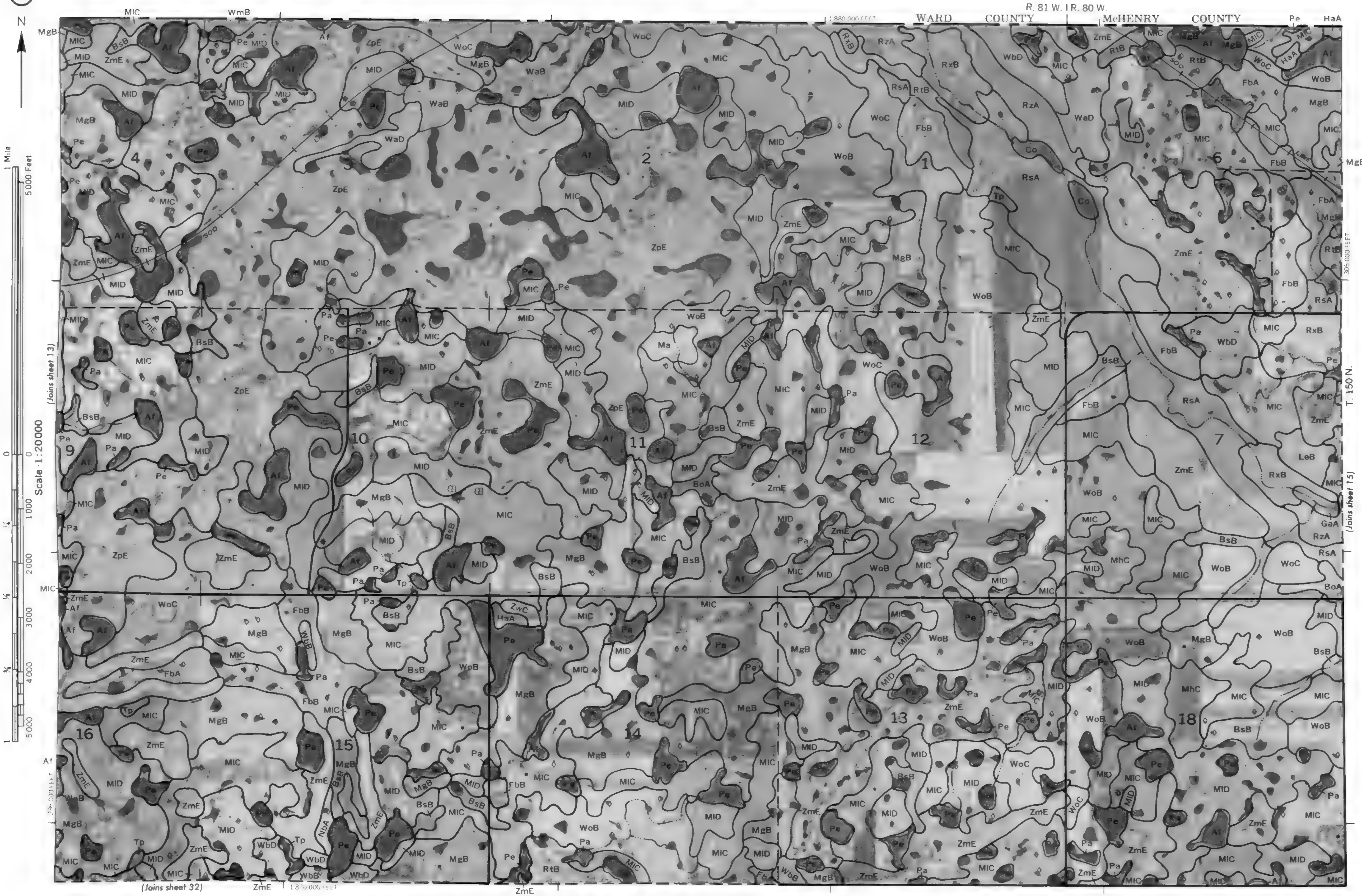

10
N
WARD COUNTY
R. 84 W. | R. 83 W.
T. 150 N.
(Joins sheet 9)
(Joins sheet 11)
(Joins sheet 28)
Scale 1:20000
1 Mile
5000 Feet
SOO LINE
1
2
3
4
6
7
9
10
11
12
13
14
15
16
18

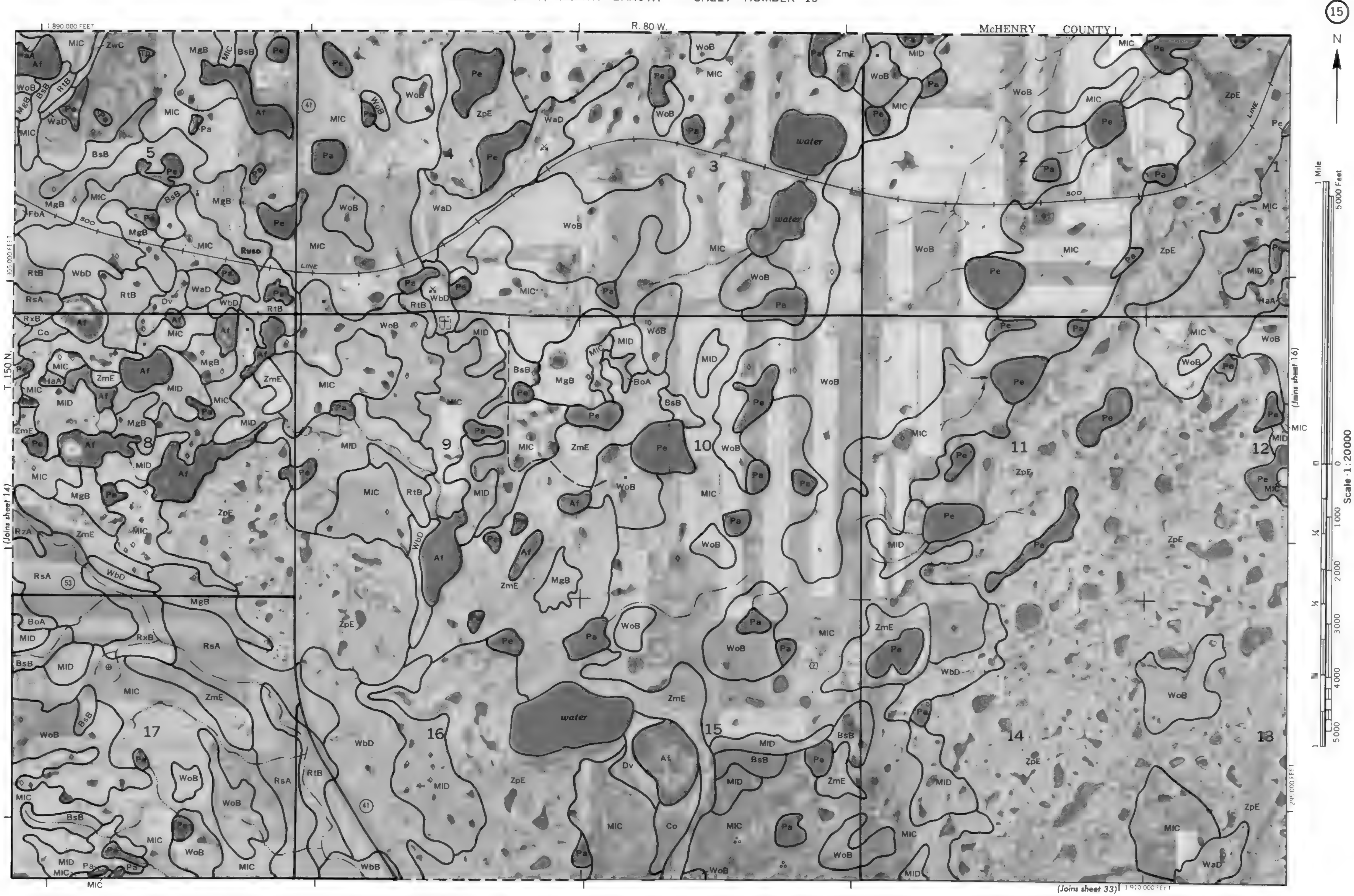
(11)

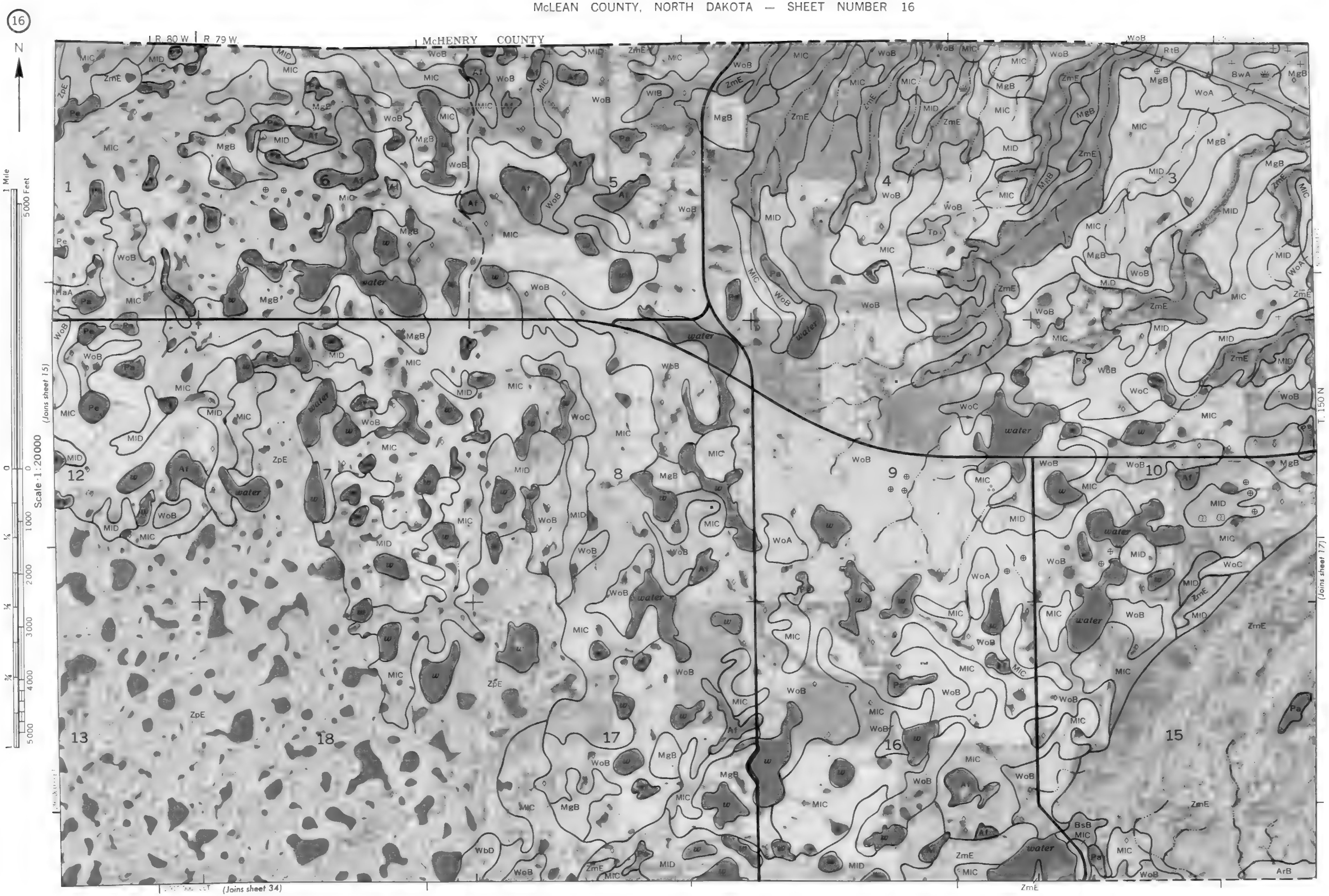

WARD COUNTY
R. 83 W.
T. 150 N.
N
(Joins sheet 10)
(Joins sheet 12)
(Joins sheet 29)
Max
SOO LINE
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17
1 Mile
5000 Feet
Scale 1:20000
Pa
Pe
Af
MIC
MID
WoA
WoB
WoC
BsB
BoA
ZmE
ZwC
HaA
Tp
Ac
RtB
WlB

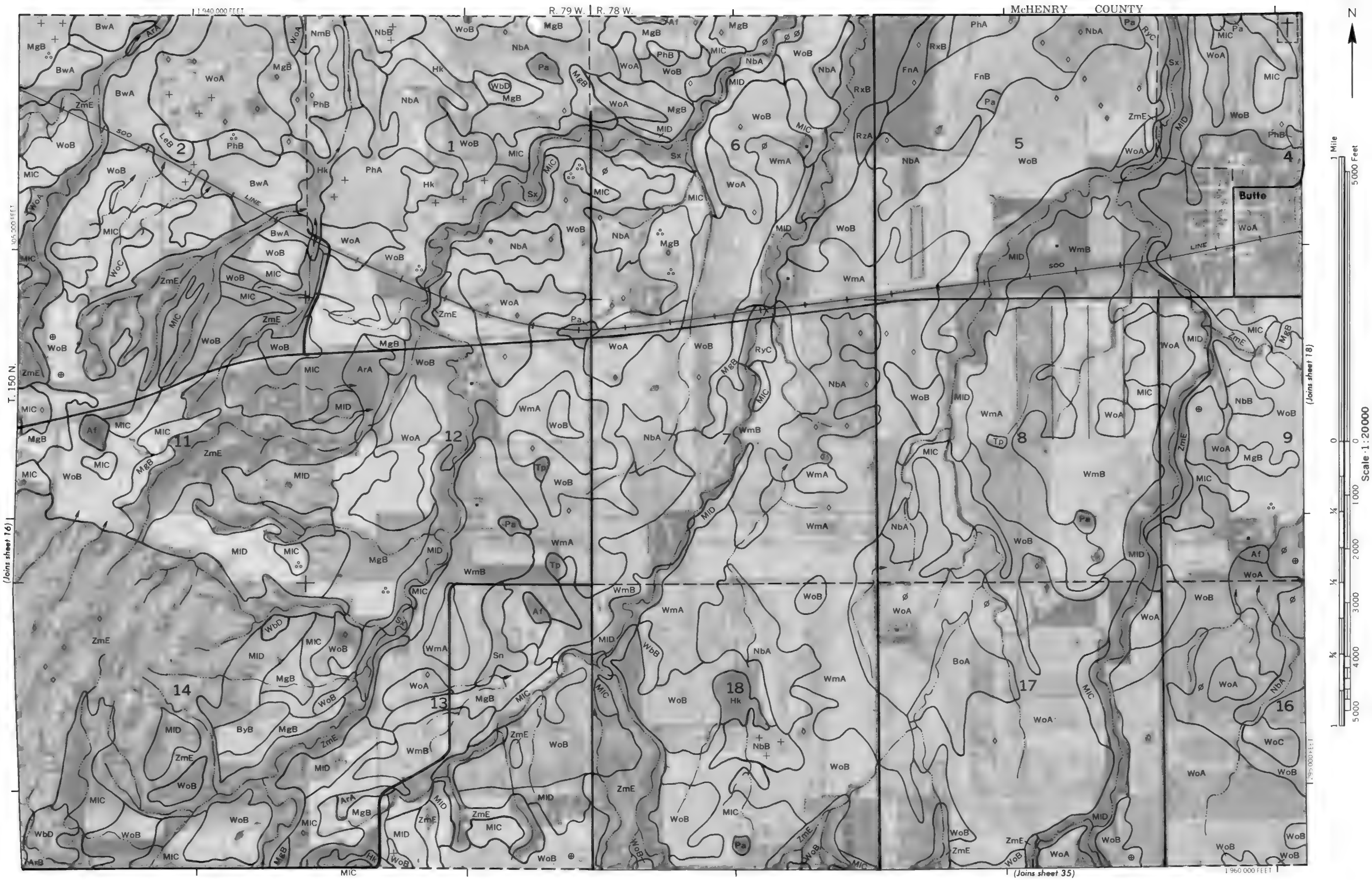

N
WARD COUNTY
R. 83 W.
R. 82 W.
T. 150 N.
(Joins sheet 11)
(Joins sheet 13)
(Joins sheet 30)
Scale 1:20000
1 Mile
5000 Feet
Intermittent
SOO LINE
1
3
4
5
6
7
8
9
10
12
13
15
16
17
18
WmB
WmA
WoB
WoA
MIC
MID
ZmE
Pe
Pa
Af
Ac
BoA
BsB
Sn
Tp
MgB
NtA
HaA
WlB
RtB
WbD

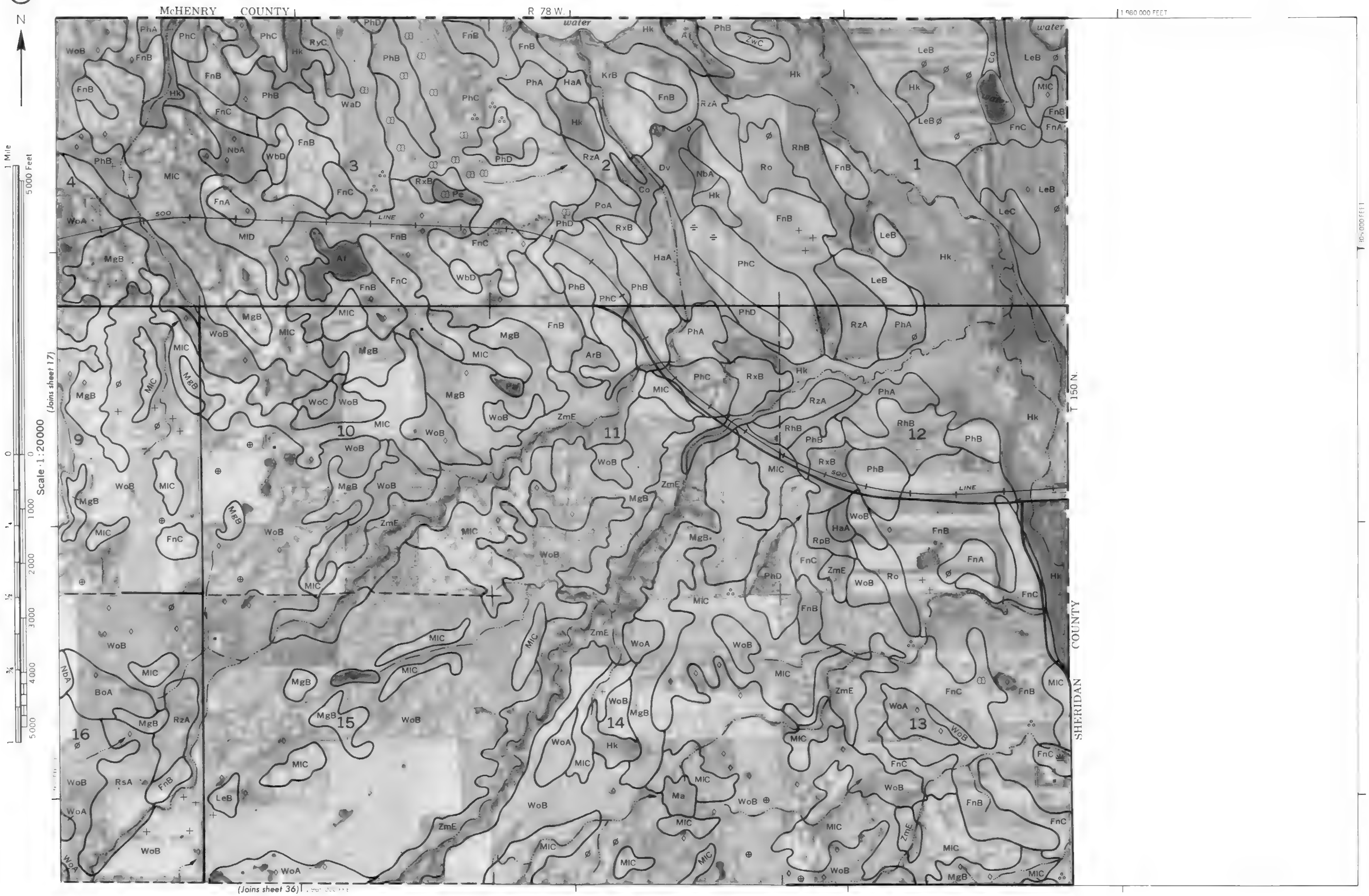

13
N
R. 82 W.
R. 81 W.
WARD COUNTY
T. 150 N.
1 845 000 FEET
310 000 FEET
295 000 FEET
1 865 000 FEET
(Joins sheet 12)
(Joins sheet 14)
(Joins sheet 31)
Benedict
water
LINE
SOO
1 Mile
5000 Feet
Scale 1:20000
53
1
2
3
4
5
6
7
8
9
11
12
13
14
16
17
18


N
WARD COUNTY
McHENRY COUNTY
R. 81 W.
R. 80 W.
T. 150 N.
1 Mile
5 000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
(Joins sheet 13)
(Joins sheet 15)
(Joins sheet 32)
880 000 FEET
305 000 FEET
1
2
3
4
5
6
7
9
10
11
12
13
14
15
16
18

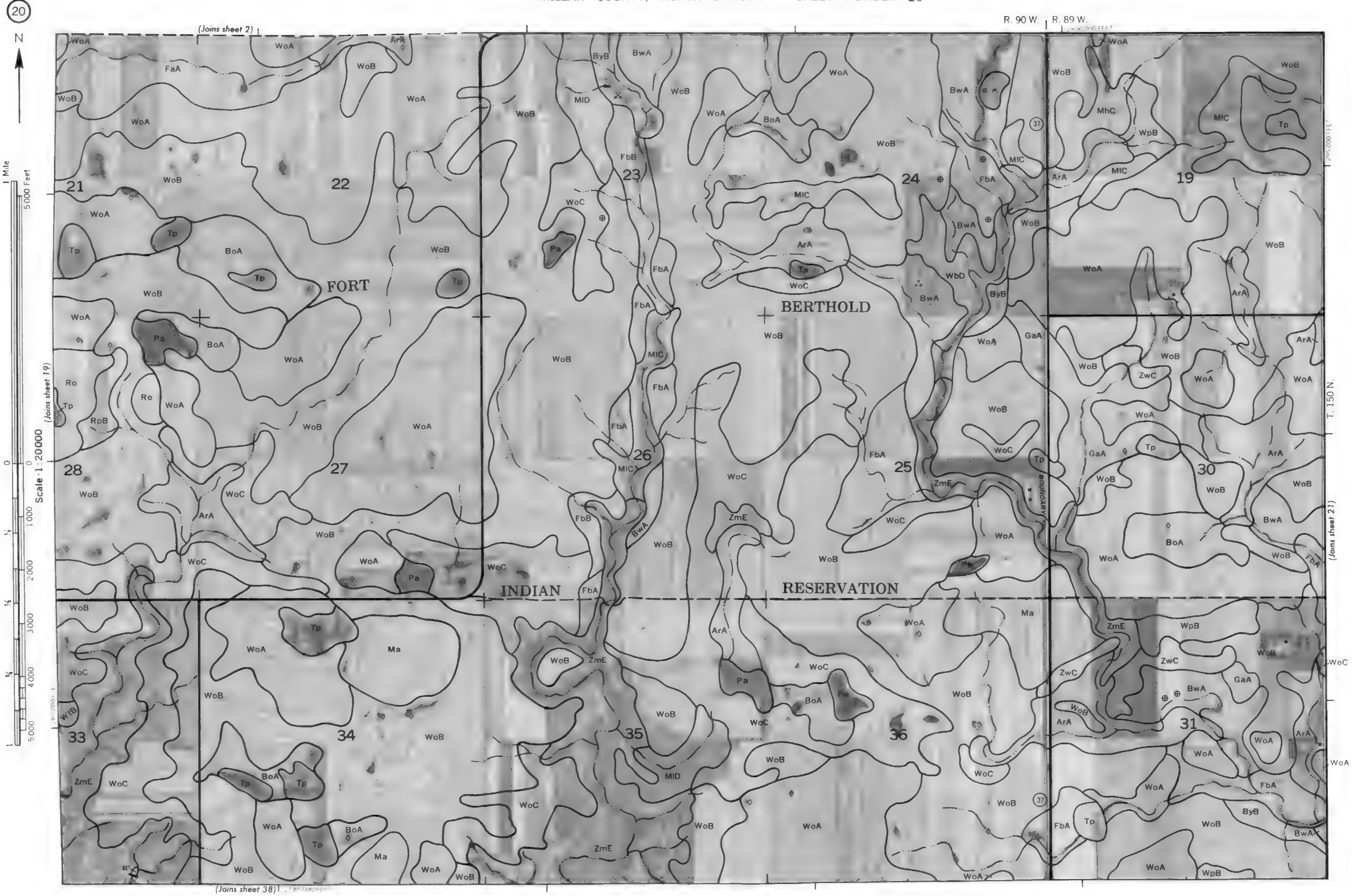

15
N
R. 80 W.
McHENRY COUNTY LINE
T. 150 N.
1 890 000 FEET
305 000 FEET
295 000 FEET
1 910 000 FEET
(Joins sheet 14)
(Joins sheet 16)
(Joins sheet 33)
SOO LINE
Ruso
water
1
2
3
5
8
9
10
11
12
13
14
15
16
17
41
53
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½

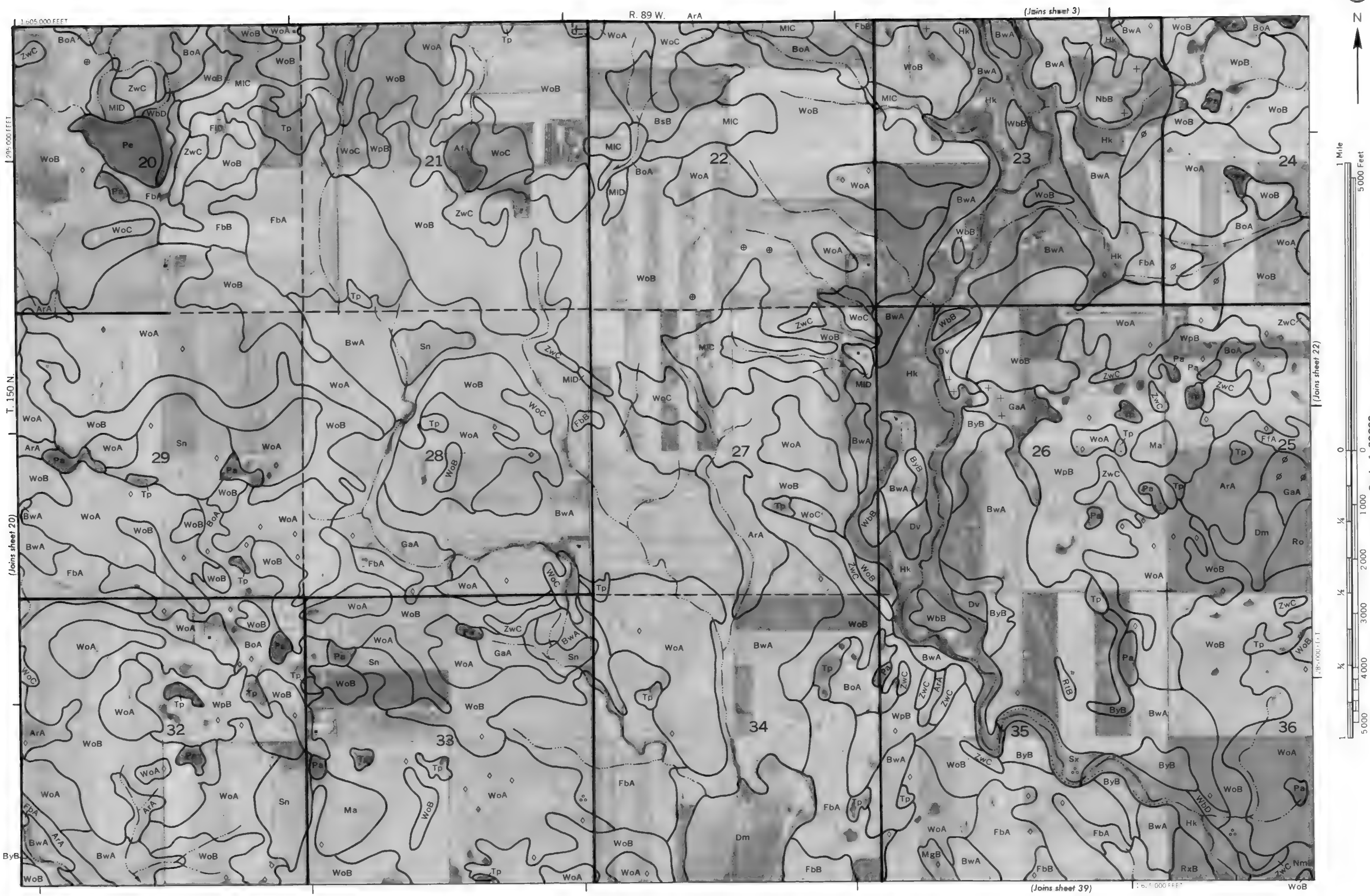

16
N
R. 80 W.
R. 79 W.
McHENRY COUNTY
(Joins sheet 15)
(Joins sheet 17)
(Joins sheet 34)
T. 150 N.
Scale 1:20000
1 Mile
5000 Feet
1
2
3
4
5
6
7
8
9
10
12
13
15
16
17
18
water
MIC
MID
WoB
WoA
WoC
MgB
ZmE
ZpE
Af
Pa
Pe
Tp
RtB
BwA
BsB
ArB
WbD
HaA


1 940 000 FEET
R. 79 W.
R. 78 W.
McHENRY COUNTY
N
T. 150 N.
(Joins sheet 16)
(Joins sheet 18)
(Joins sheet 35)
1 960 000 FEET
SOO LINE
Butte
1 Mile
5000 Feet
Scale 1:20000
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18

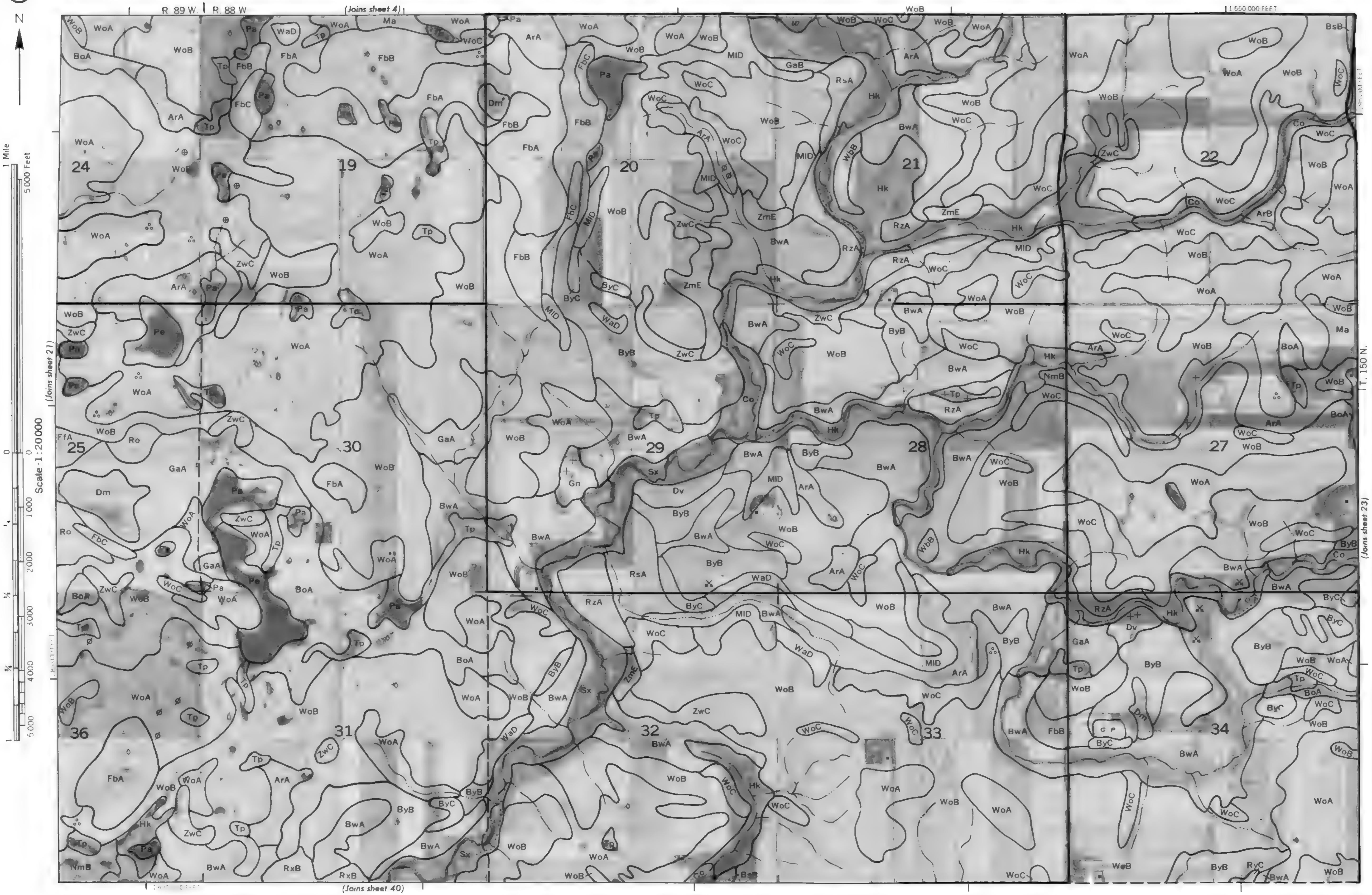

N
McHENRY COUNTY
R 78 W.
1 960 000 FEET
water
SOO LINE
T 150 N.
SHERIDAN COUNTY
(Joins sheet 17)
(Joins sheet 36)
Scale 1:20000
1 Mile
5000 Feet
1
2
3
4
9
10
11
12
13
14
15
16


(Joins sheet 1)
R. 90 W.
1 560 000 FEET
295 000 FEET
T. 150 N.
LAKE
SAKAKAWEA
Lucky Mound Creek Bay
DUNN COUNTY
FORT
BERTHOLD
INDIAN
RESERVATION
19
20
21
28
29
30
31
32
33
(Joins sheet 20)
(Joins sheet 37)
1 580 000 FEET
N
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
WwC
ZmE
WtB
Pa
FaA
WoA
WoB
FbB
ZcE
WbD
MdB
Ro
Tp
WoC
MlD

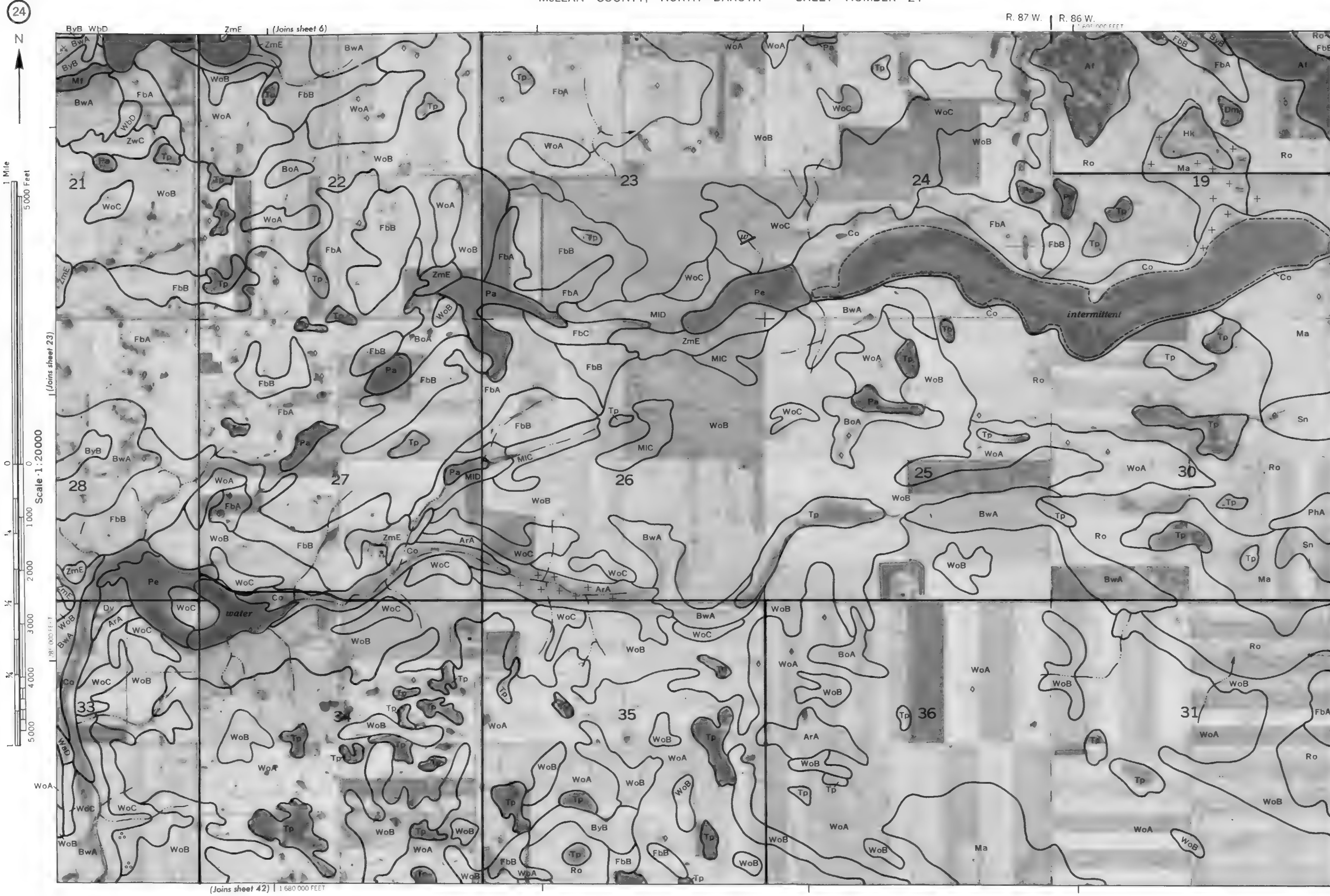

20
N
(Joins sheet 2)
(Joins sheet 19)
(Joins sheet 21)
(Joins sheet 38)
R. 90 W.
R. 89 W.
T. 150 N.
FORT
BERTHOLD
INDIAN
RESERVATION
BOUNDARY
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
37

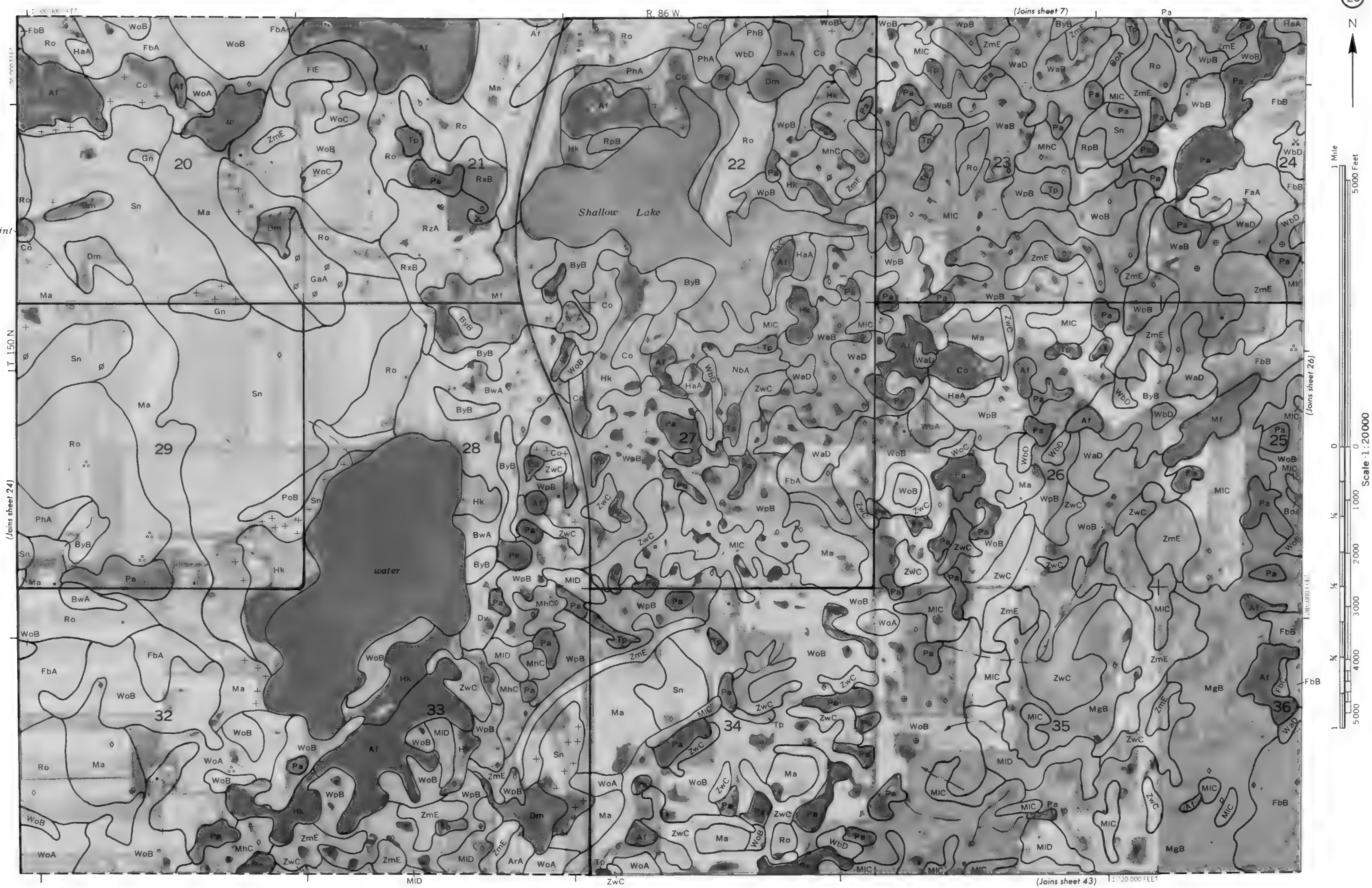


N
1 605 000 FEET
R. 89 W.
(Joins sheet 3)
(Joins sheet 22)
(Joins sheet 20)
(Joins sheet 39)
T. 150 N.
295 000 FEET
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
1 Mile
5000 Feet
Scale 1:20000

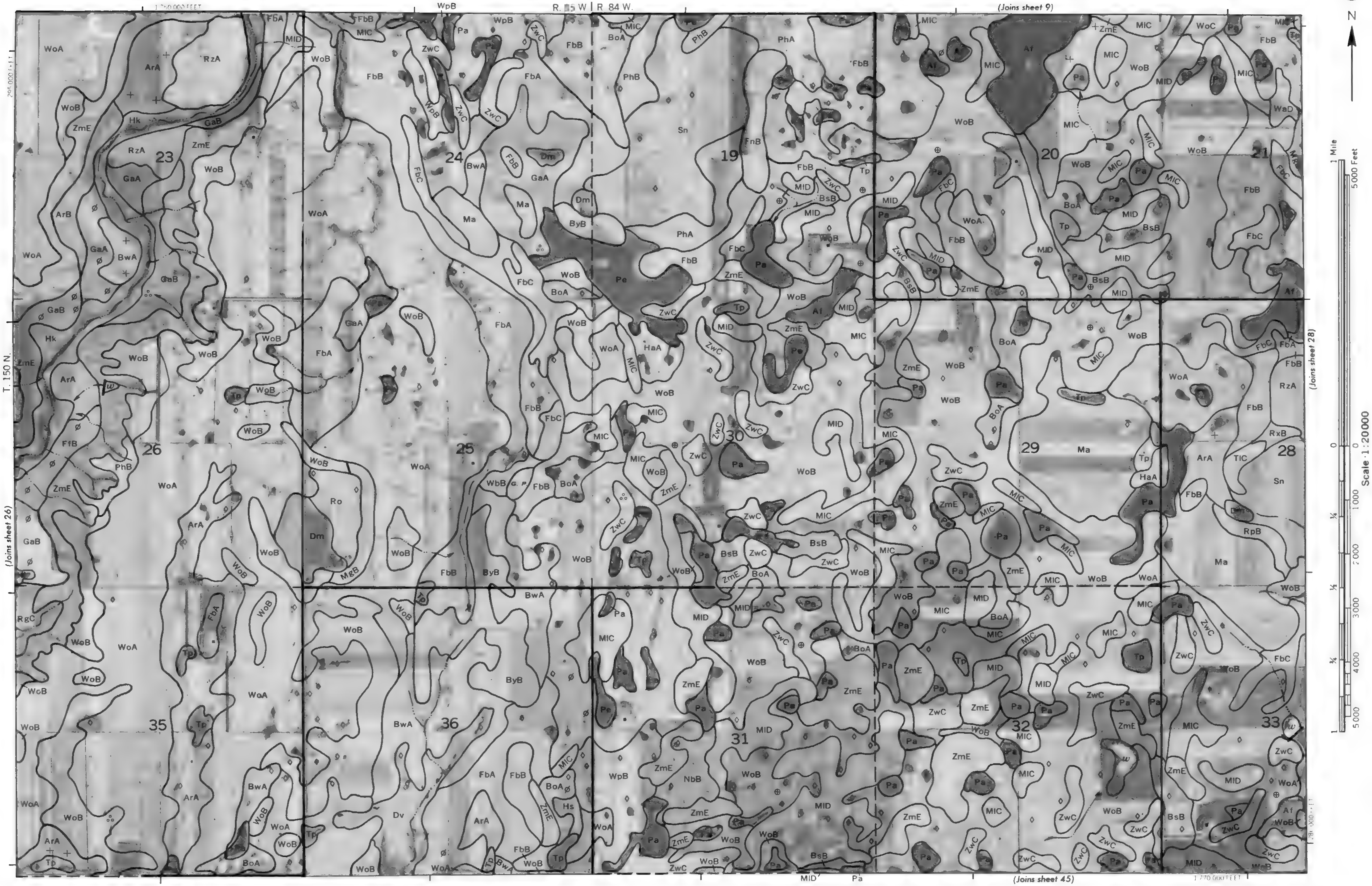

N
R. 89 W.
R. 88 W.
(Joins sheet 4)
1 650 000 FEET
(Joins sheet 21)
(Joins sheet 23)
(Joins sheet 40)
T. 150 N.
Scale 1:20000
1 Mile
5000 Feet
24
19
20
21
22
25
30
29
28
27
36
31
32
33
34

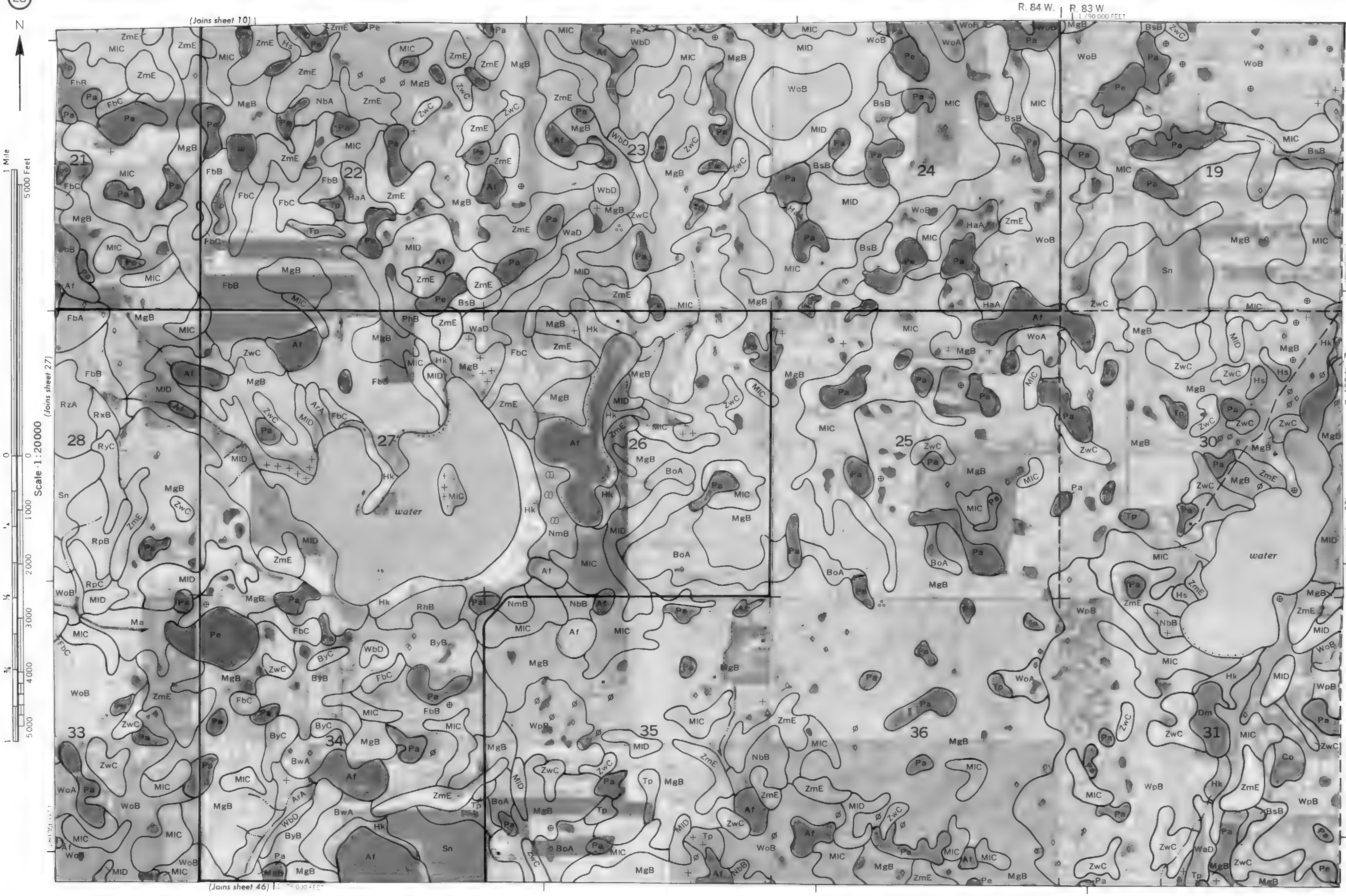

(Joins sheet 5)
R. 88 W.
R. 87 W.
T. 150 N.
(Joins sheet 22)
(Joins sheet 24)
(Joins sheet 41)
N
1 Mile
5000 Feet
Scale 1:20000
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33

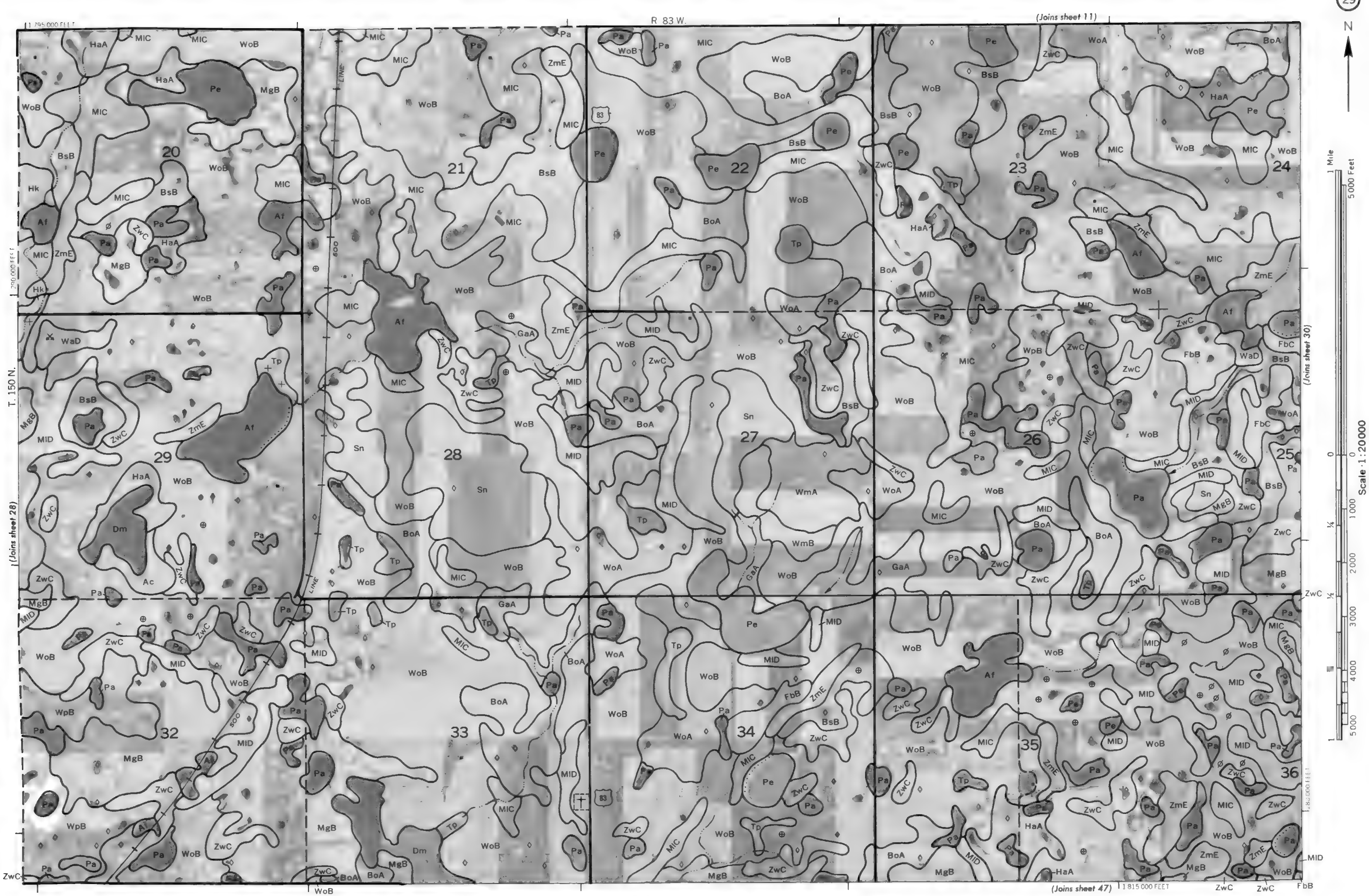

24
N
(Joins sheet 6)
R. 87 W.
R. 86 W.
1 680 000 FEET
(Joins sheet 23)
(Joins sheet 25)
(Joins sheet 42)
T. 150 N.
1 Mile
5 000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
intermittent
water
19
21
22
23
24
25
26
27
28
30
31
33
34
35
36
ByB
WbD
ZmE
BwA
Mf
FbA
FbB
FbC
WoA
WoB
WoC
ZwC
Tp
Pa
Pe
BoA
Af
Dm
Hk
Ma
Ro
Co
MlD
MlC
ArA
Dy
Sn
PhA
ByB

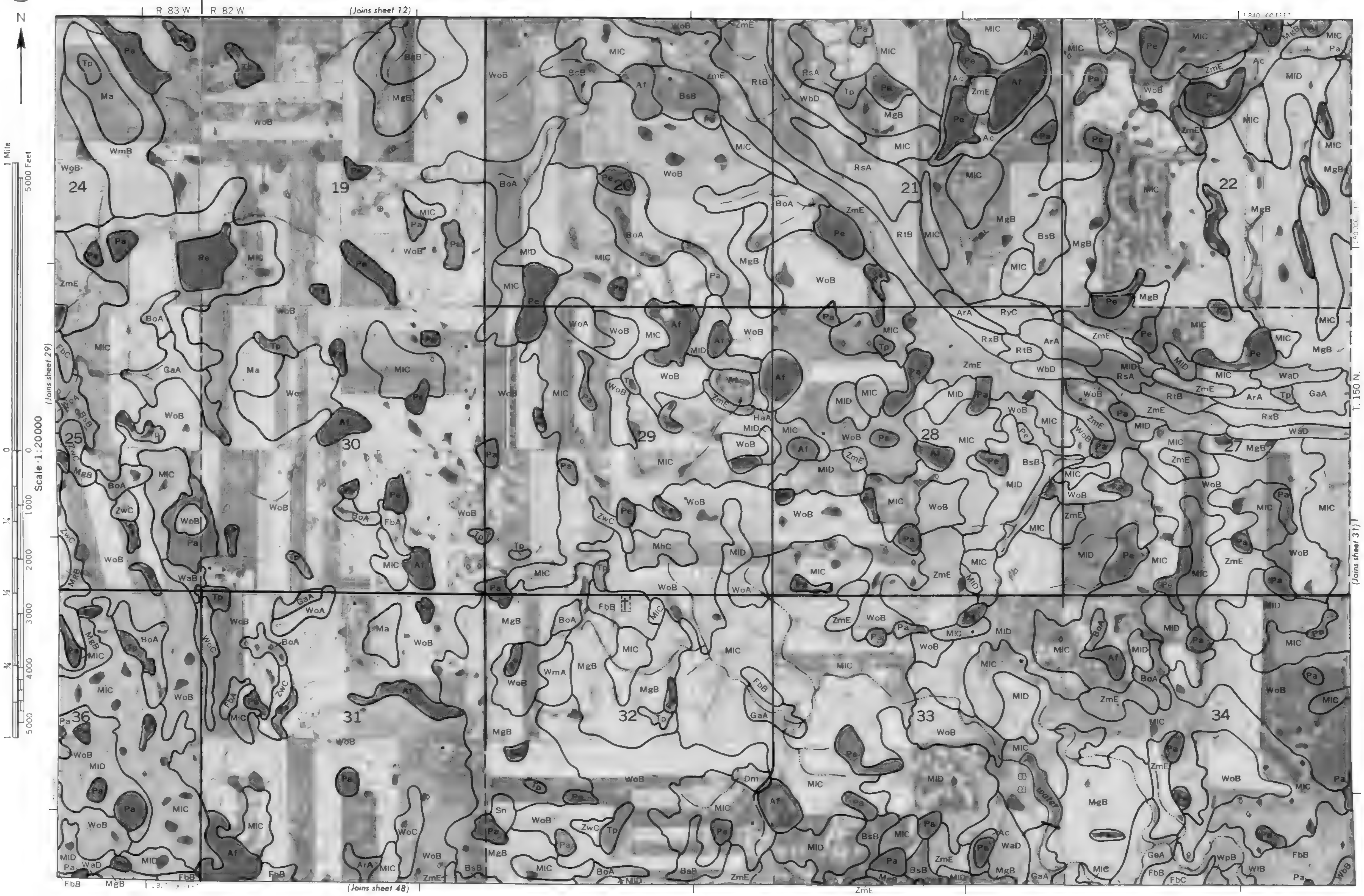

25
N
(Joins sheet 7)
R. 86 W.
T. 150 N.
(Joins sheet 24)
(Joins sheet 26)
(Joins sheet 43)
Shallow Lake
water
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1


26
N
R. 86 W.
R. 85 W.
(Joins sheet 8)
(Joins sheet 25)
(Joins sheet 27)
(Joins sheet 44)
T. 150 N.
Scale 1:20000
1 Mile
5000 Feet
1 725 000 FEET
DOUGLAS CREEK
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36


R. 85 W. | R. 84 W.
(Joins sheet 9)
(Joins sheet 28)
(Joins sheet 45)
(Joins sheet 26)
T. 150 N.
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33

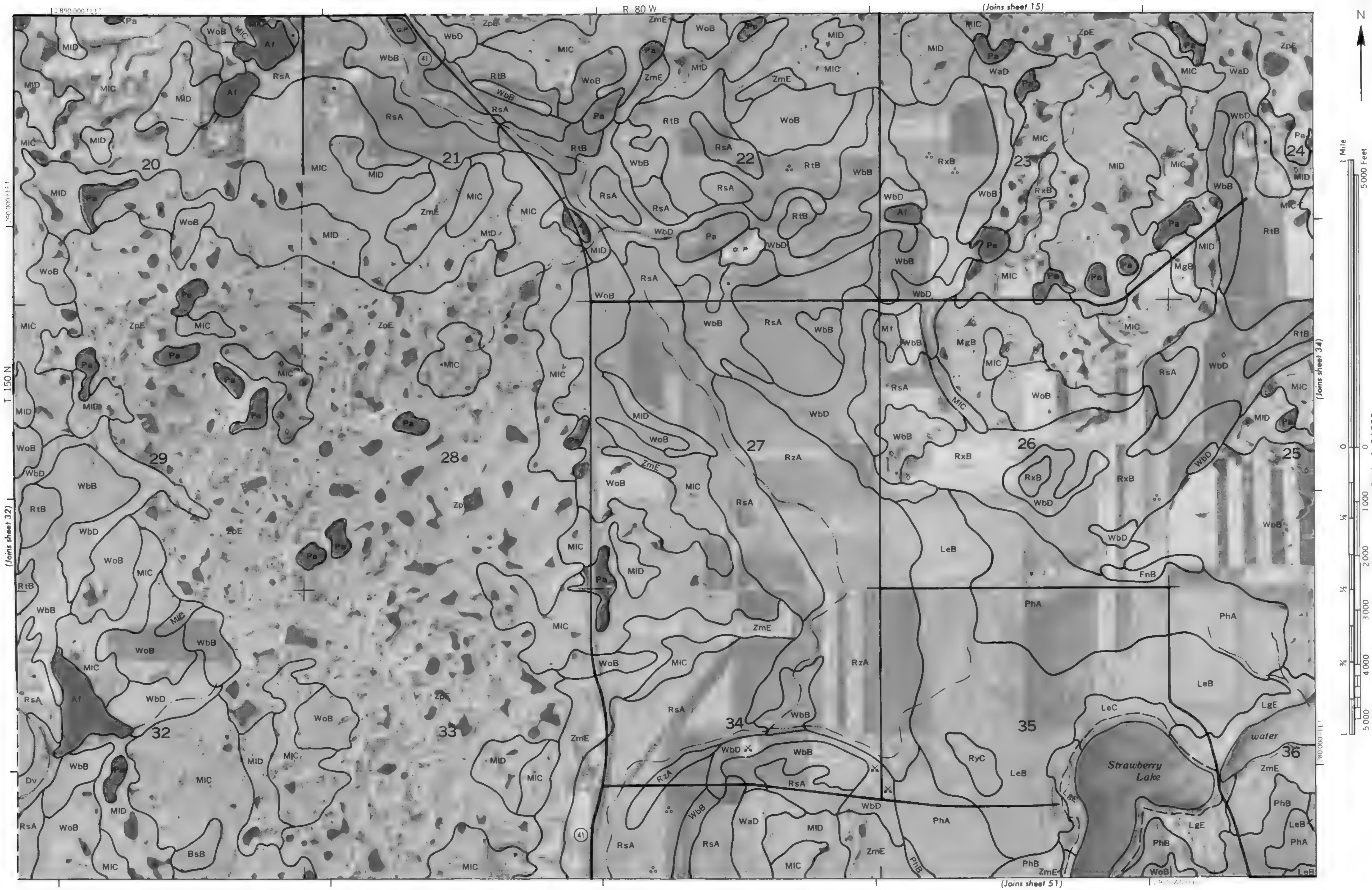

N
(Joins sheet 10)
R. 84 W.
R. 83 W
1 790 000 FEET
(Joins sheet 27)
(Joins sheet 29)
(Joins sheet 46)
T. 150 N
Scale 1:20000
1 Mile
5000 Feet
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
water
water

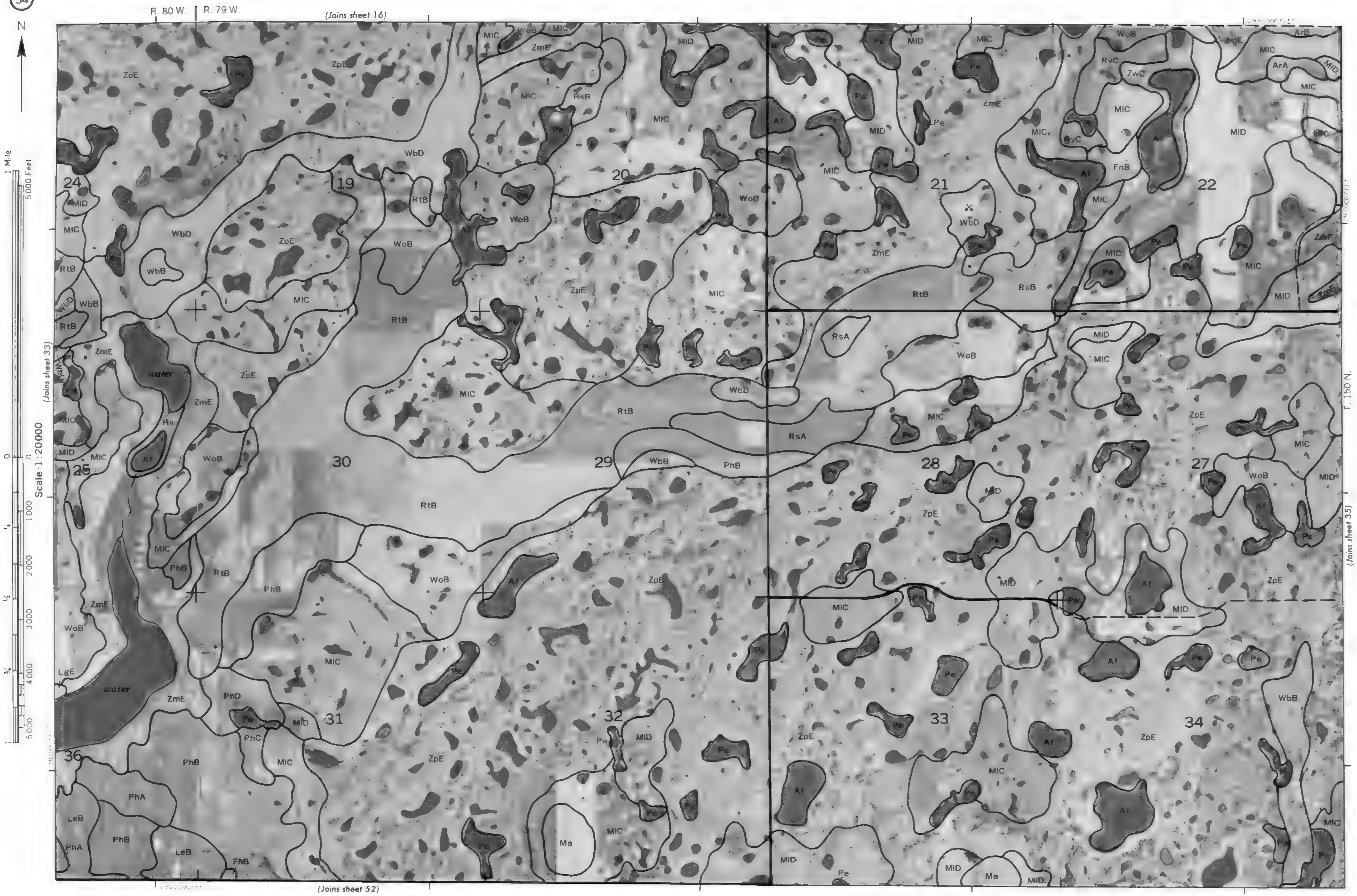

29
N
R. 83 W.
T. 150 N.
(Joins sheet 11)
(Joins sheet 30)
(Joins sheet 28)
(Joins sheet 47)
1 795 000 FEET
1 815 000 FEET
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
1 Mile
5000 Feet
Scale 1:20000


N
R 83 W
R 82 W
(Joins sheet 12)
(Joins sheet 29)
(Joins sheet 31)
(Joins sheet 48)
T. 150 N.
Scale 1:20000
1 Mile
5000 Feet
24
19
20
21
22
25
30
29
28
27
36
31
32
33
34


31
N
R. 82 W.
R. 81 W.
(Joins sheet 13)
(Joins sheet 32)
(Joins sheet 49)
(Joins sheet 30)
T. 150 N.
1 840 000 FEET
1 865 000 FEET
290 000 FEET
280 000 FEET
1 Mile
5000 Feet
Scale 1:20000
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33

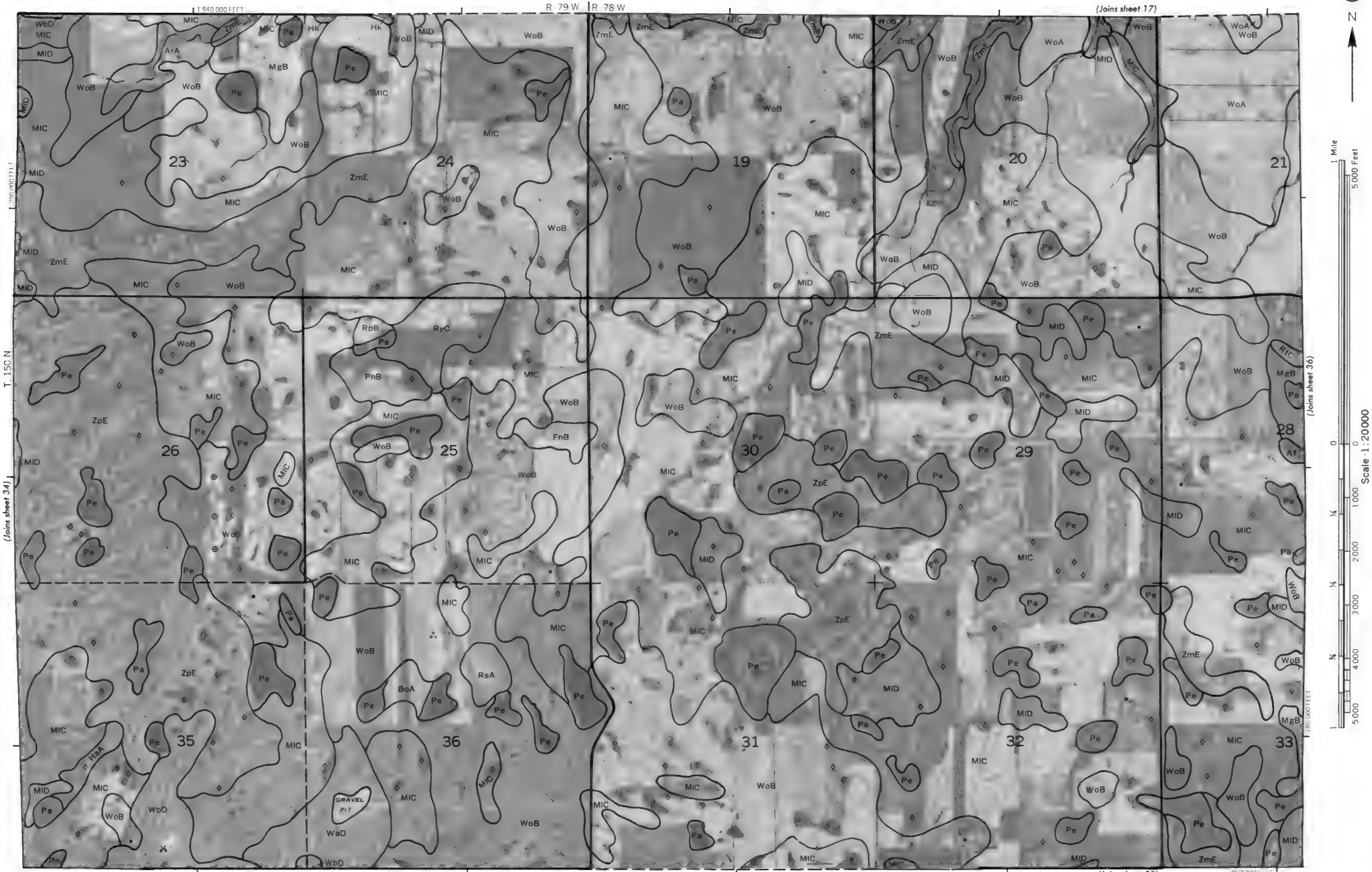

32
N
(Joins sheet 14)
R. 81 W.
R. 80 W.
(Joins sheet 31)
(Joins sheet 33)
(Joins sheet 50)
T. 150 N.
Scale 1:20000
1 Mile
5000 Feet
21
22
23
24
19
27
26
25
30
28
33
34
35
36
31

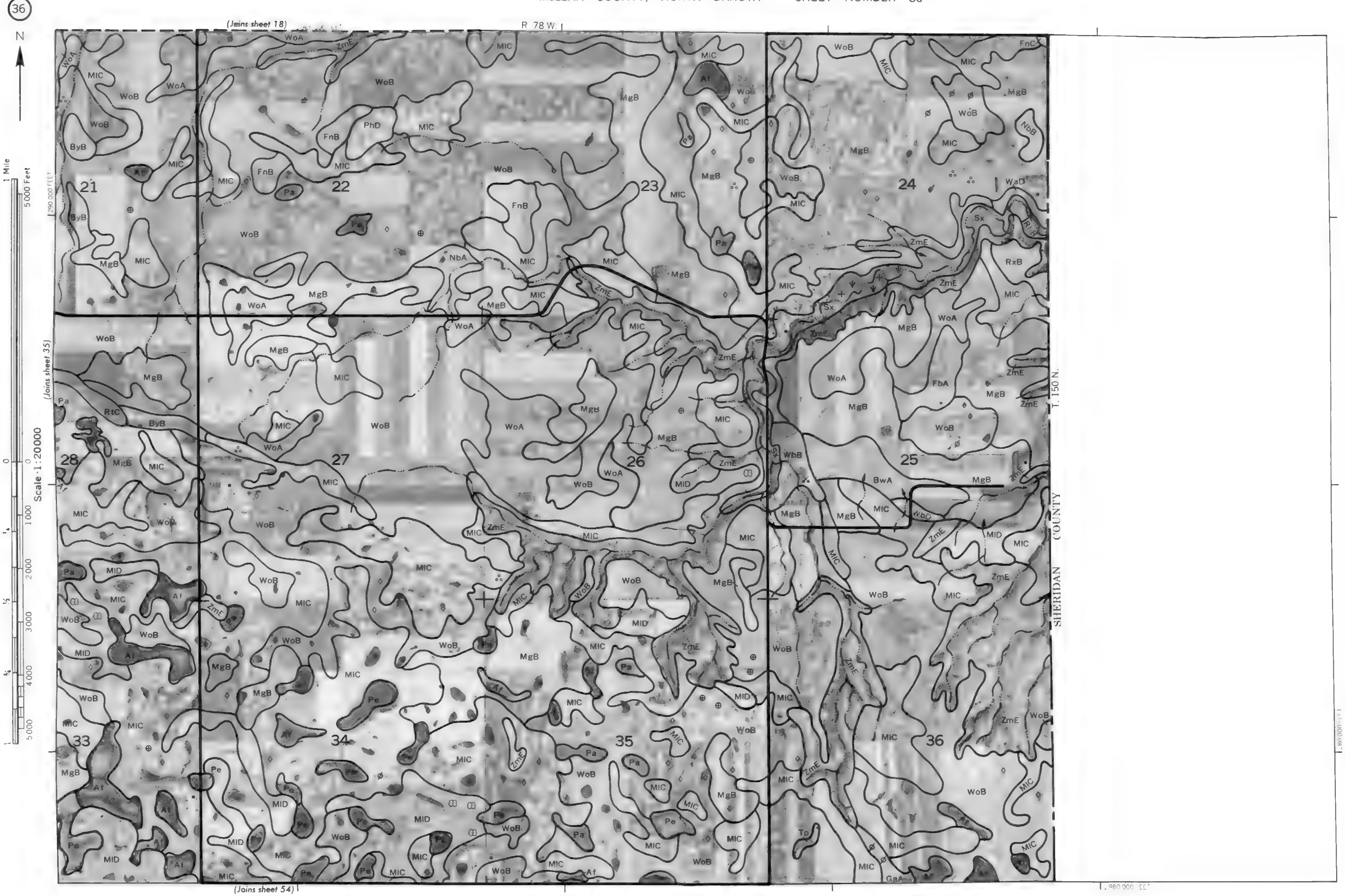

N
R 80 W
(Joins sheet 15)
(Joins sheet 32)
(Joins sheet 34)
(Joins sheet 51)
T 150 N
1 890 000 FEET
1 Mile
5000 Feet
Scale 1:20000
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
Strawberry Lake
water
MIC
MID
WoB
WbB
WbD
RsA
RtB
RxB
RzA
Pa
Pe
Af
ZpE
ZmE
LeB
LeC
LgE
PhA
PhB
FnB
MgB
RyC
WaD
BsB
Dv
Mf
G.P.


R. 80 W.
R. 79 W.
(Joins sheet 16)
(Joins sheet 33)
(Joins sheet 35)
(Joins sheet 52)
T. 150 N.
N
1 Mile
5000 Feet
Scale 1:20000
24
19
20
21
22
25
30
29
28
27
36
31
32
33
34
water
water

McLEAN COUNTY, NORTH DAKOTA — SHEET NUMBER 35

35

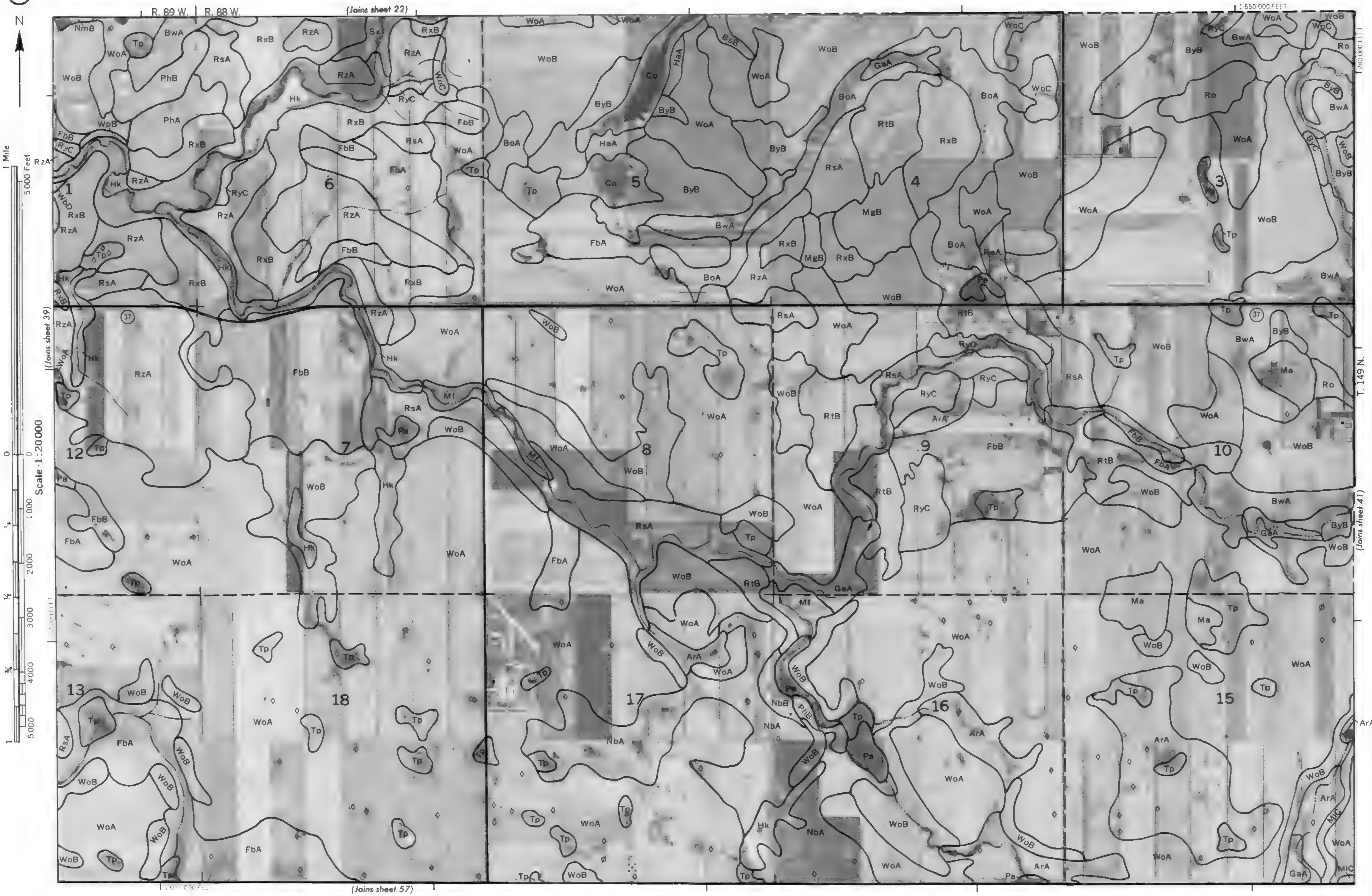



36
N
(Joins sheet 18)
R. 78 W.
(Joins sheet 35)
(Joins sheet 54)
T. 150 N.
SHERIDAN COUNTY
1 Mile
5000 Feet
Scale 1:20000
21
22
23
24
25
26
27
28
33
34
35
36
WoA
WoB
MIC
MID
MgB
ByB
FnB
PhD
NbA
ZmE
Pa
Pe
At
Af
Sx
RxB
FbA
BwA
WbB
WbD
NbB
FnC
RtC
Tp
GaA
WaD

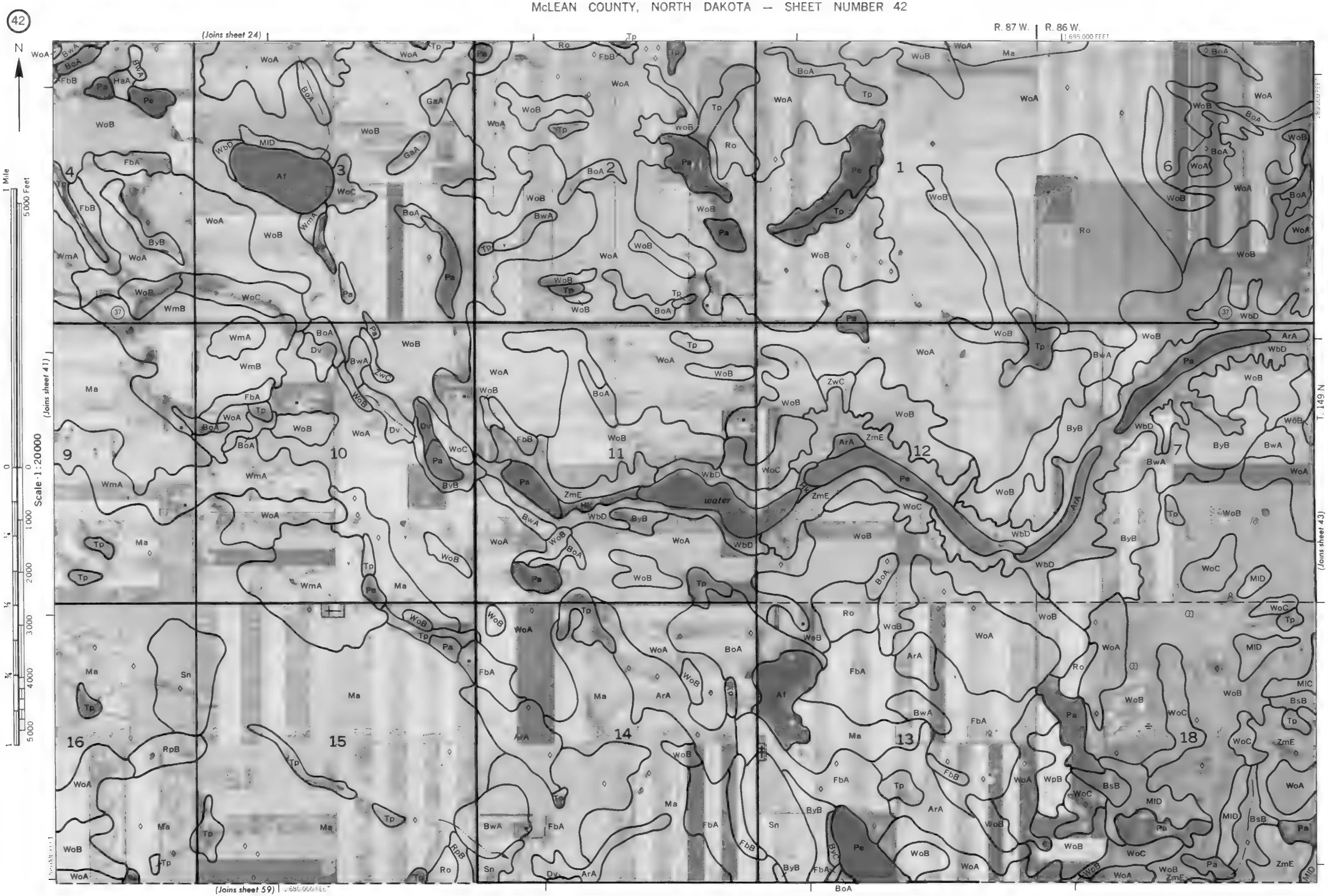

37
N
R. 90 W.
(Joins sheet 19)
(Joins sheet 38)
(Joins inset, sheet 72)
T. 149 N.
LAKE
SAKAKAWEA
DUNN
COUNTY
FORT
BERTHOLD
INDIAN
RESERVATION
DEEPWATER
CREEK
BAY
ZcE
WwC
MdB
MlD
ZmE
WoC
CaE
ByB
WtB
MdA
FfA
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
4
5
6
7
8
9
16
17
18

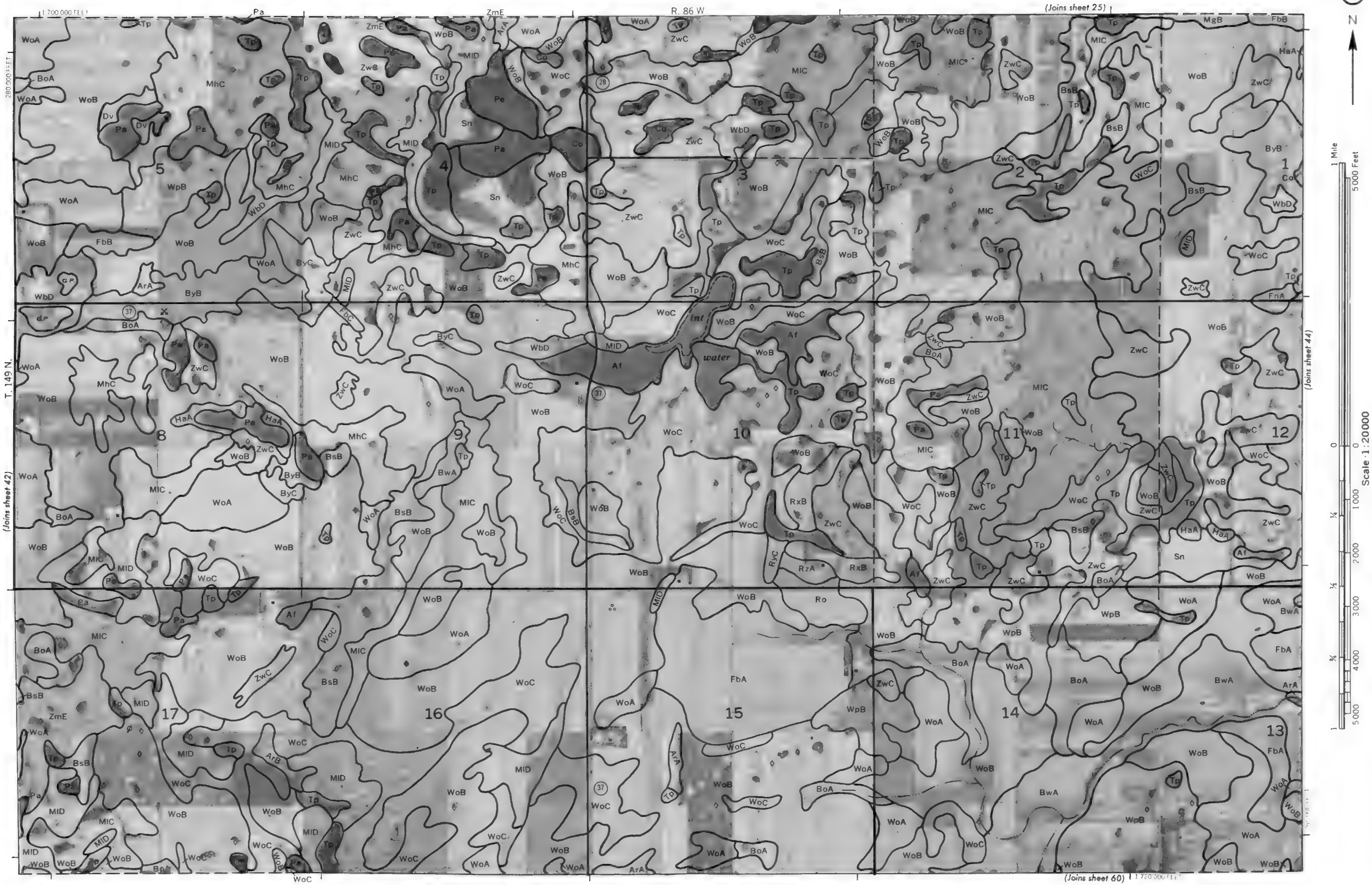

N
(Joins sheet 20)
R. 90 W.
R. 89 W.
1 600 000 FEET
280 000 FEET
T. 149 N.
(Joins sheet 37)
(Joins sheet 39)
(Joins sheet 55)
1 585 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
FORT
BERTHOLD
INDIAN
RESERVATION
BOUNDARY
DEEPWATER
CREEK
BAY
water
1
2
3
4
6
7
9
10
11
12
13
16
18
37
ZmE
MID
WoB
Ma
WoA
WoC
FfB
FfA
ZcE
ByB
FbB
Tp
FbA
BwA
MhC
WpB
Pa
BsB
ZwC
BoA
MIC
St
WbD
Bw
ArA
FaB
Sx
WtB
FbA
FbB

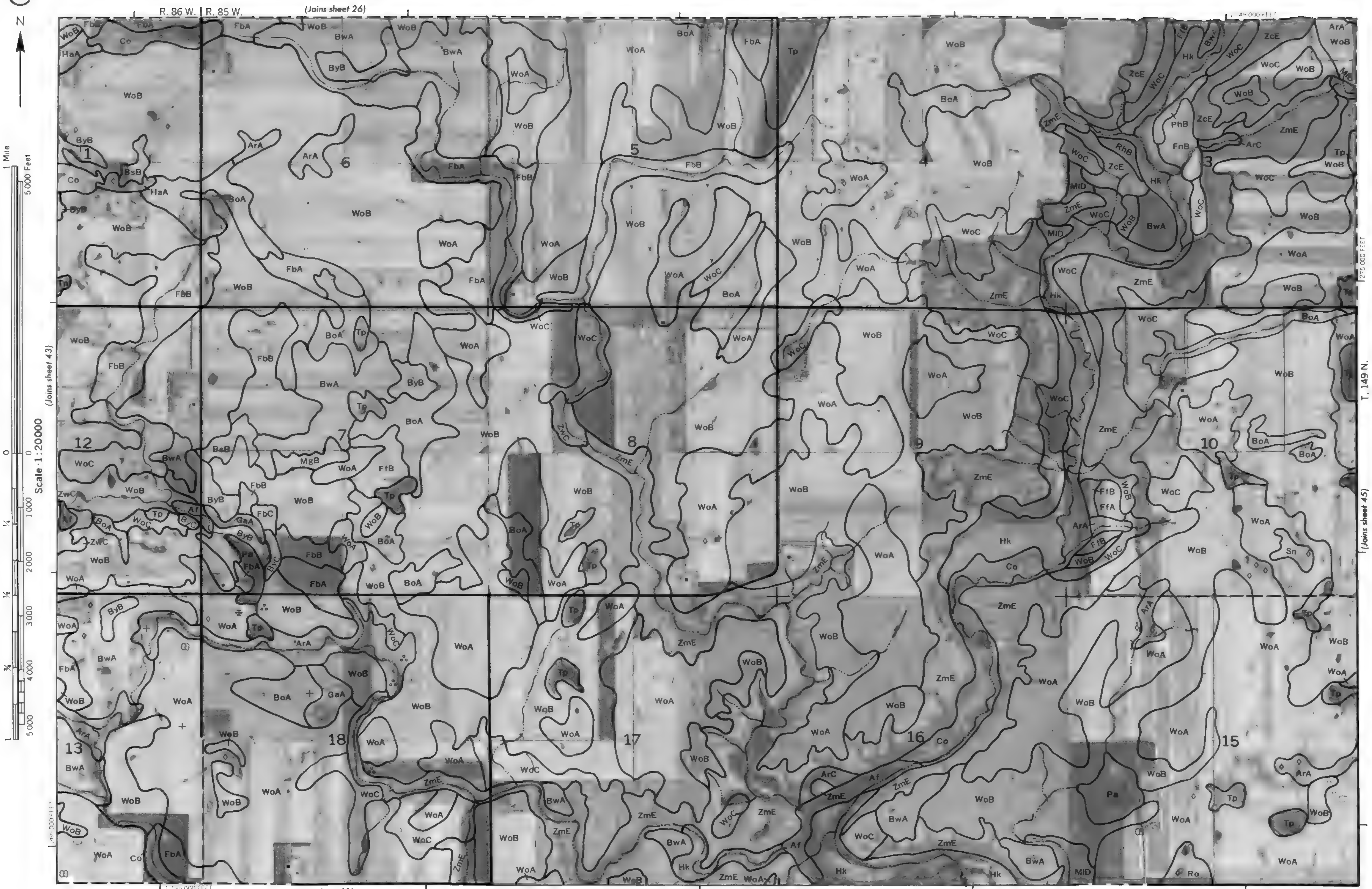

(Joins sheet 21)
R. 89 W.
T. 149 N.
(Joins sheet 40)
(Joins sheet 38)
(Joins sheet 56)
N
Scale 1:20000
1 Mile
5000 Feet
Deep Water Creek
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17


N
R. 89 W.
R. 88 W.
(Joins sheet 22)
(Joins sheet 39)
(Joins sheet 41)
(Joins sheet 57)
T. 149 N.
1 650 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
1
3
4
5
6
7
8
9
10
12
13
15
16
17
18
37
NmB
BwA
Tp
WoA
WoB
RsA
PhB
PhA
RxB
RzA
Sx
RyC
Hk
WoC
FbB
FbA
WpB
RyD
HaA
Co
BsB
ByB
GaA
BoA
RtB
MgB
Ro
BwA
Pe
Ma
Mf
Pa
ArA
NbB
NbA
MIC


41
N
(Joins sheet 23)
(Joins sheet 42)
(Joins sheet 58)
(Joins sheet 40)
R. 88 W.
R. 87 W.
T. 149 N.
1 655 000 FEET
1 675 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000

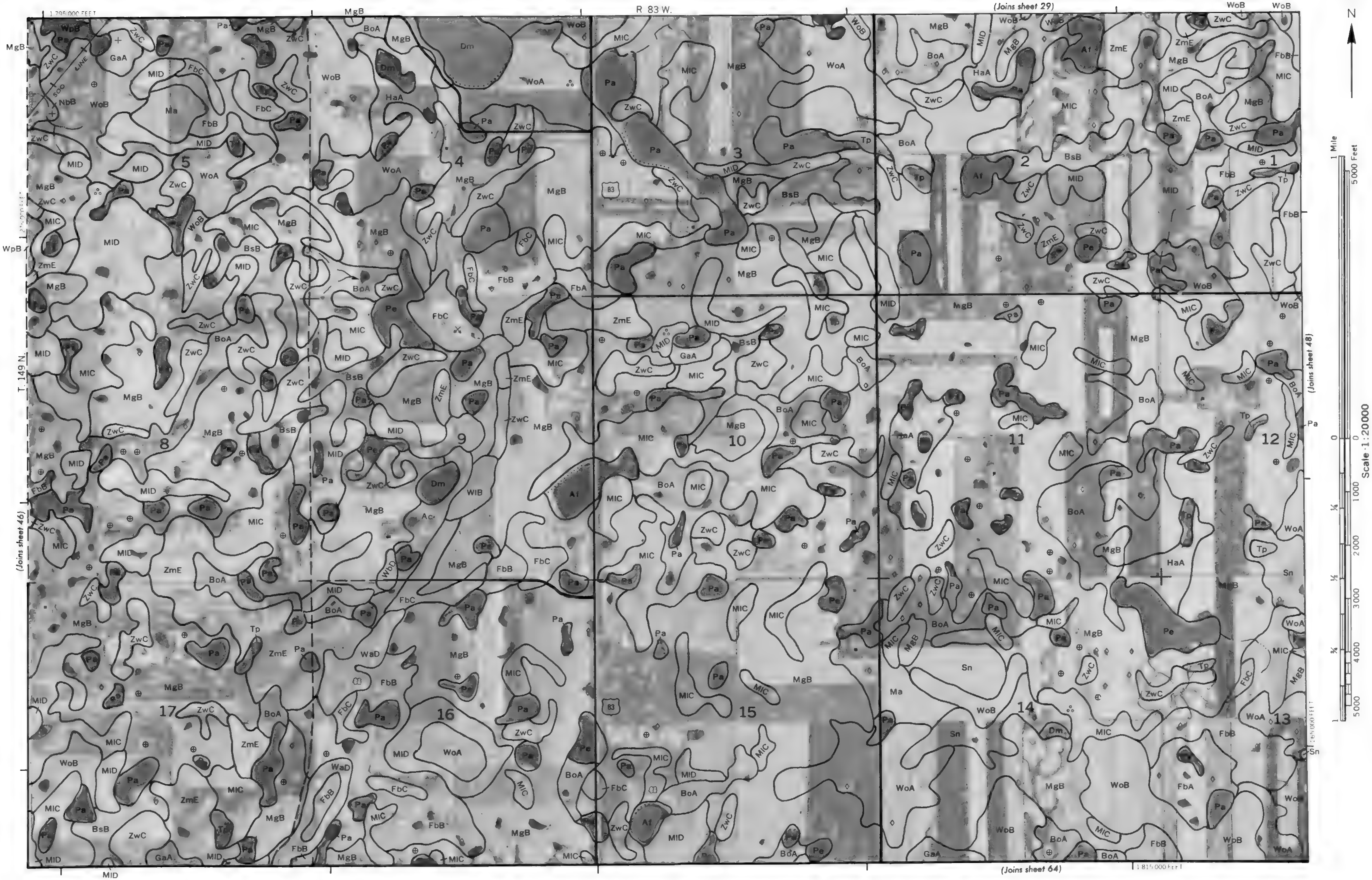

42
N
(Joins sheet 24)
R. 87 W.
R. 86 W.
1 695 000 FEET
(Joins sheet 41)
(Joins sheet 43)
(Joins sheet 59)
T. 149 N.
1 Mile
5000 Feet
Scale 1:20000
1
2
3
4
6
7
9
10
11
12
13
14
15
16
18
water

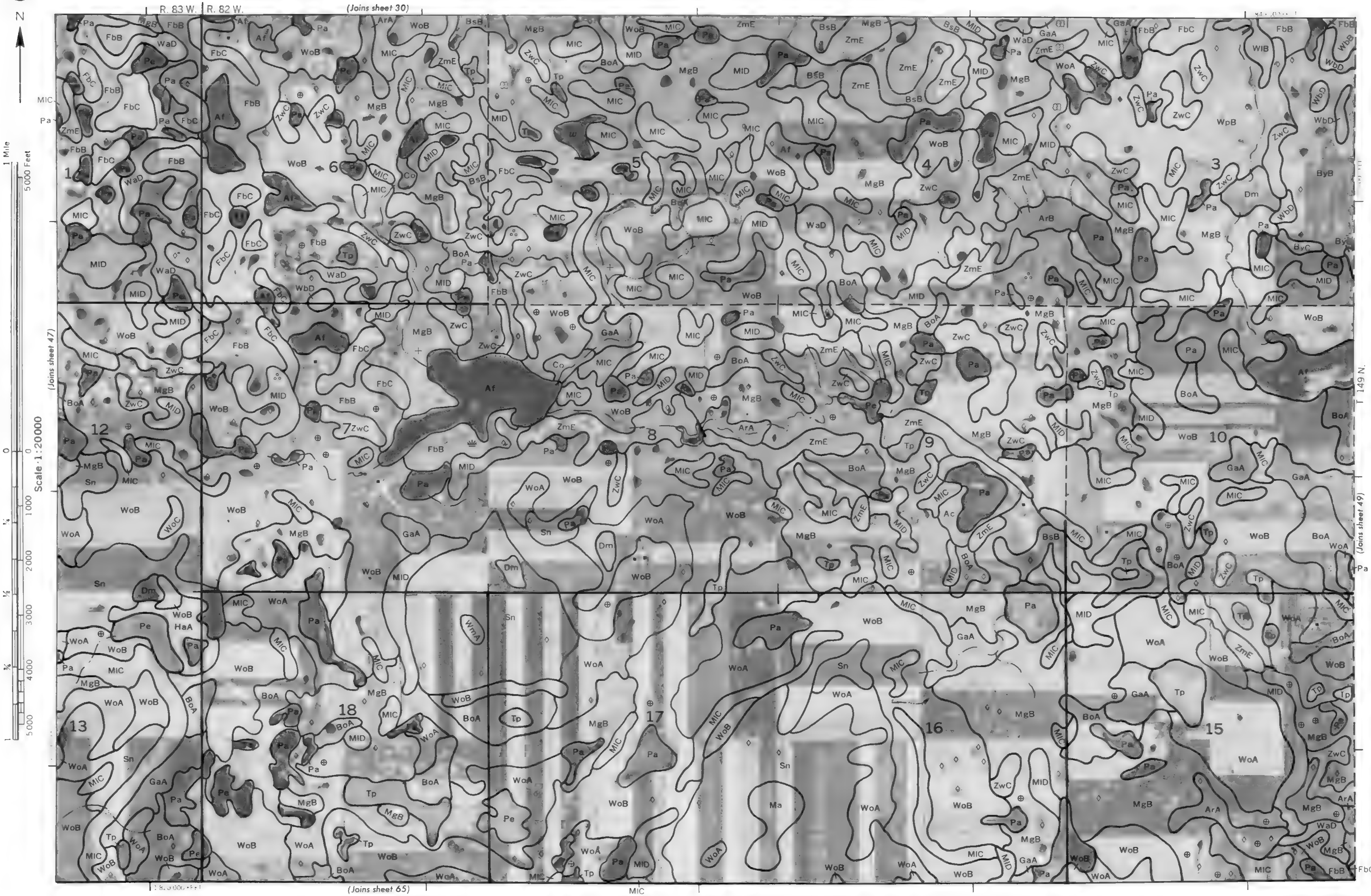

1 700 000 FEET
R. 86 W
(Joins sheet 25)
N
280 000 FEET
T. 149 N.
(Joins sheet 42)
(Joins sheet 44)
(Joins sheet 60)
1 720 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
1000
2000
3000
4000
5000
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17
water
37
28


N
R. 86 W.
R. 85 W.
(Joins sheet 26)
(Joins sheet 43)
(Joins sheet 45)
(Joins sheet 61)
T. 149 N.
Scale 1:20000
1 Mile
5000 Feet
1
3
4
5
6
7
8
9
10
12
13
15
16
17
18

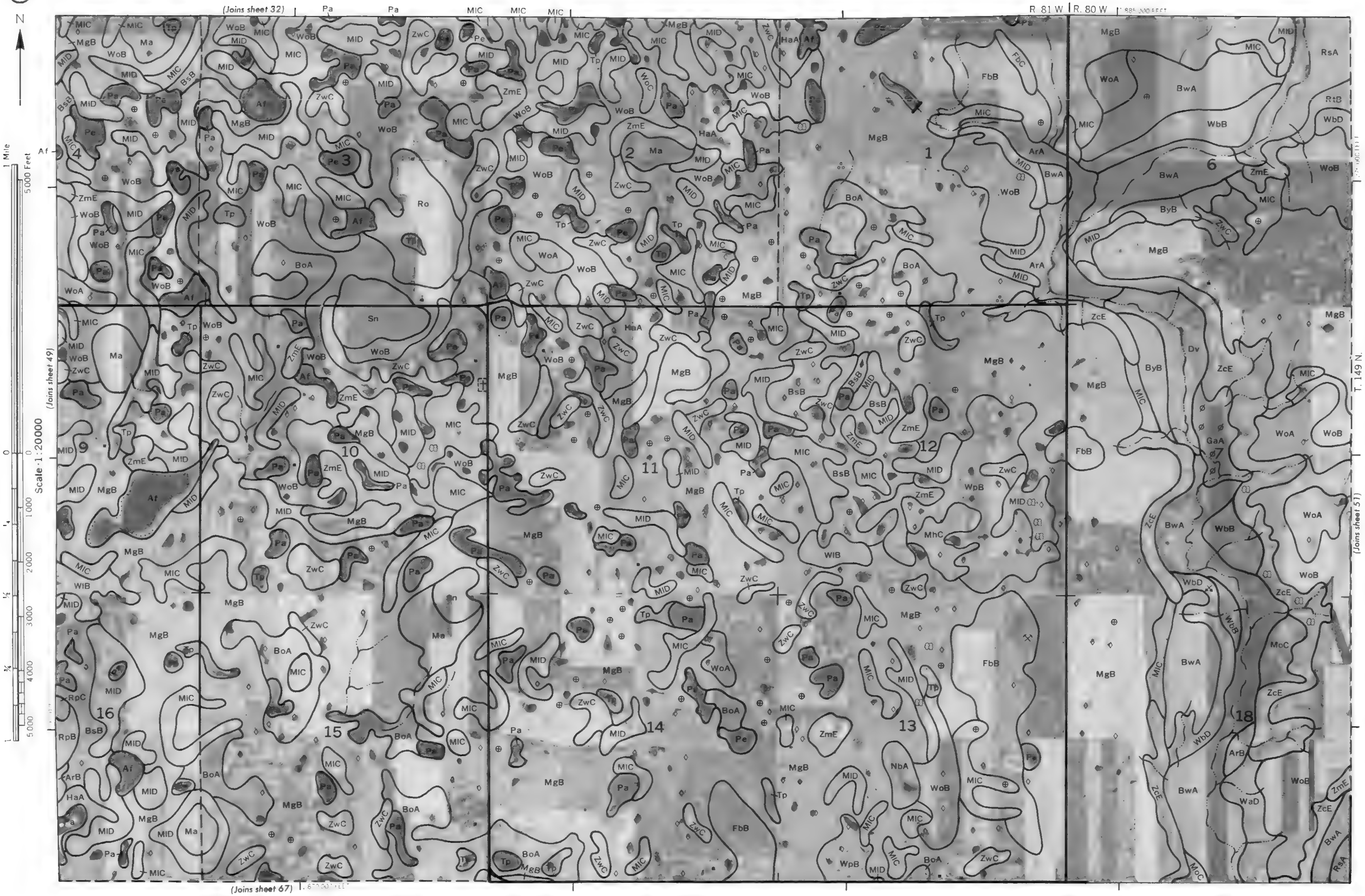
McLEAN COUNTY, NORTH DAKOTA — SHEET NUMBER 45


N
R. 84 W.
R. 83 W.
(Joins sheet 28)
(Joins sheet 45)
(Joins sheet 47)
(Joins sheet 63)
T. 149 N.
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
0
1000
2000
3000
4000
5000
1
2
3
4
6
7
9
10
11
12
13
14
15
16
18
water
SOO LINE

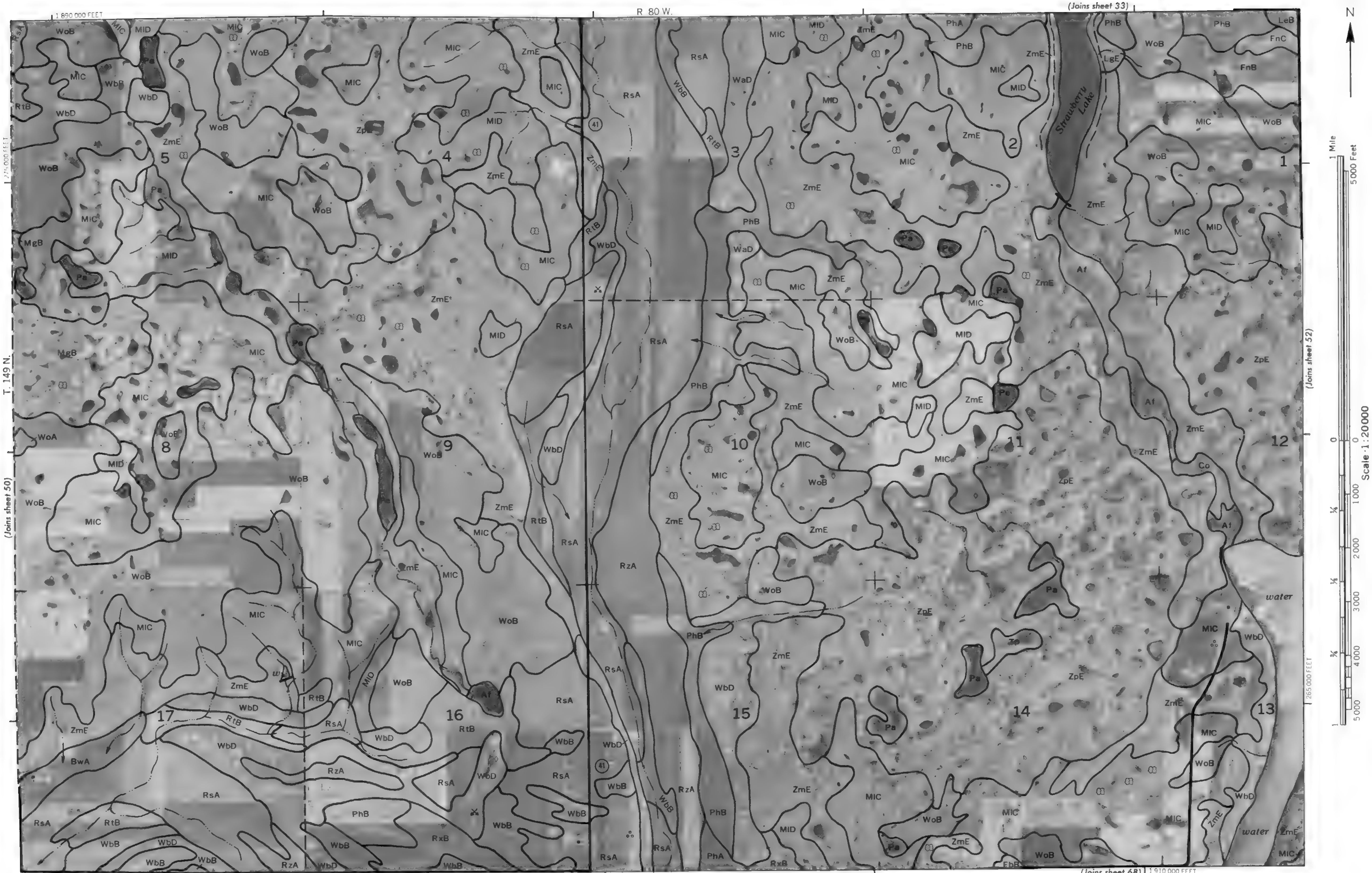

1 795 000 FEET
R. 83 W.
(Joins sheet 29)
T. 149 N.
(Joins sheet 46)
(Joins sheet 48)
(Joins sheet 64)
1 815 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17


N
R. 83 W.
R. 82 W.
(Joins sheet 30)
(Joins sheet 47)
(Joins sheet 49)
(Joins sheet 65)
T. 149 N.
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1

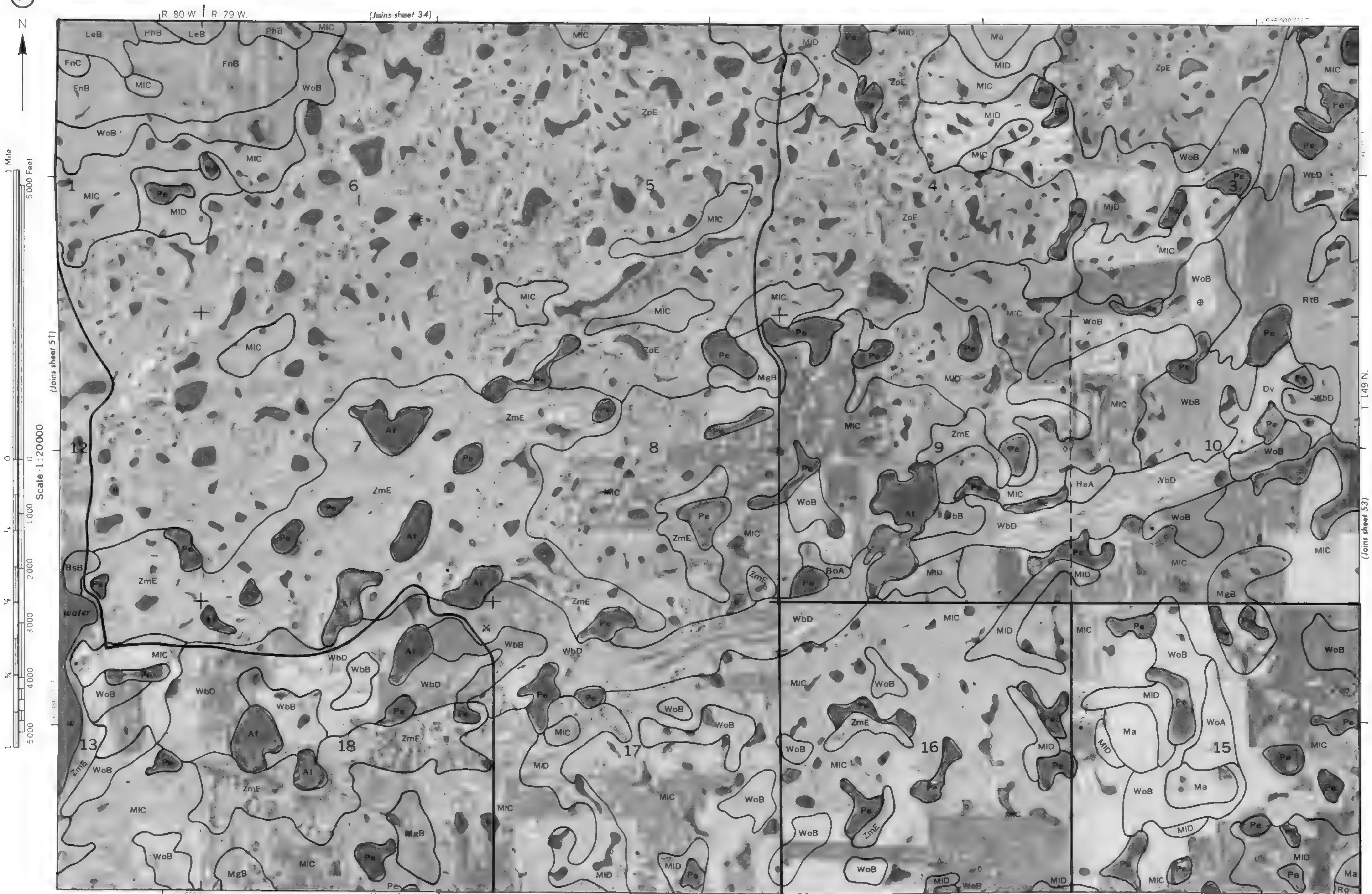

49
N
R. 82 W. | R. 81 W.
(Joins sheet 31)
(Joins sheet 50)
(Joins sheet 66)
(Joins sheet 48)
T. 149 N.
1 845 000 FEET
1 865 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000

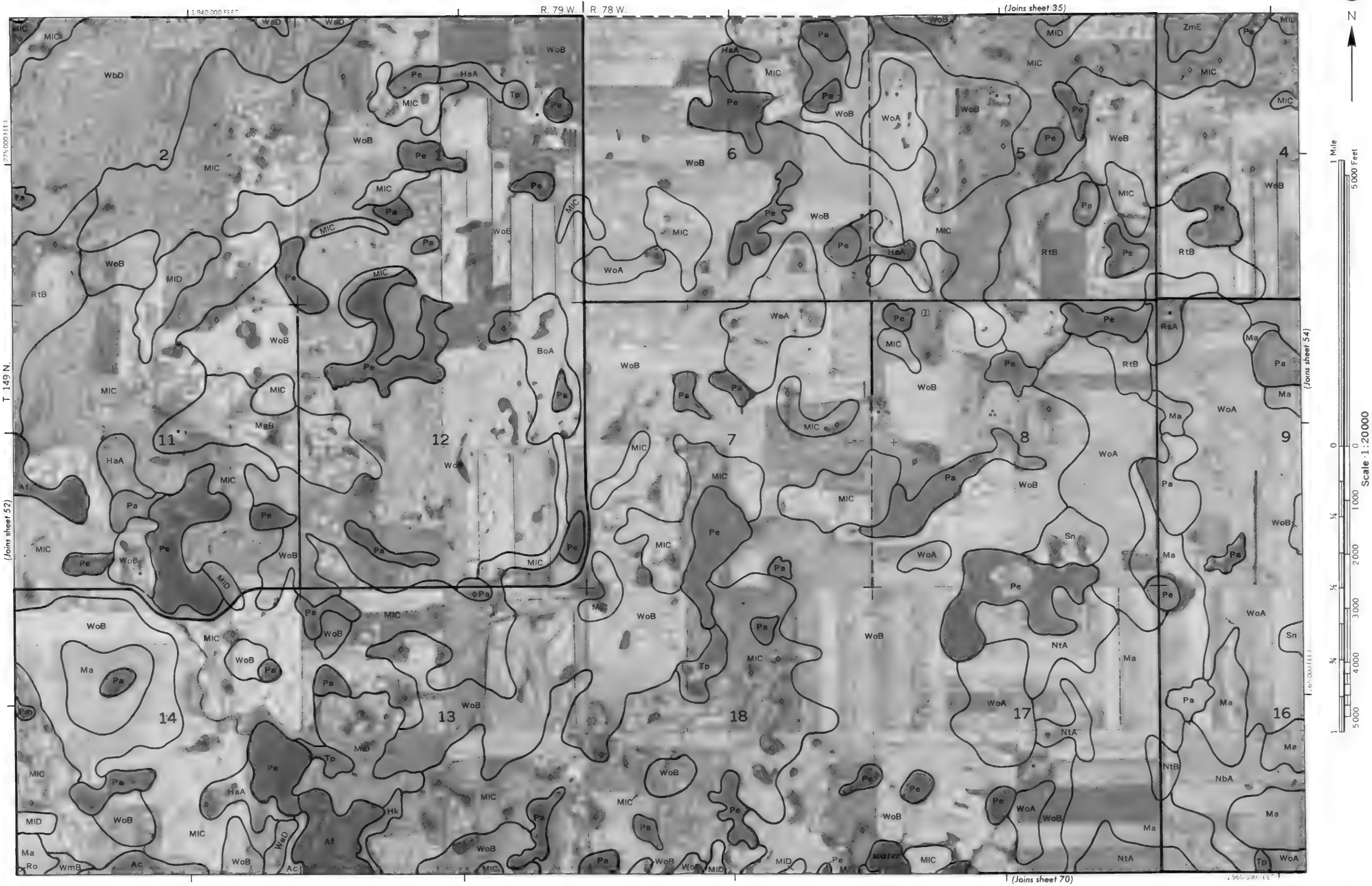

N
(Joins sheet 32)
R. 81 W
R. 80 W
(Joins sheet 49)
(Joins sheet 51)
T. 149 N.
(Joins sheet 67)
1 Mile
5000 Feet
Scale 1:20000
1
2
3
4
6
7
9
10
11
12
13
14
15
16
18

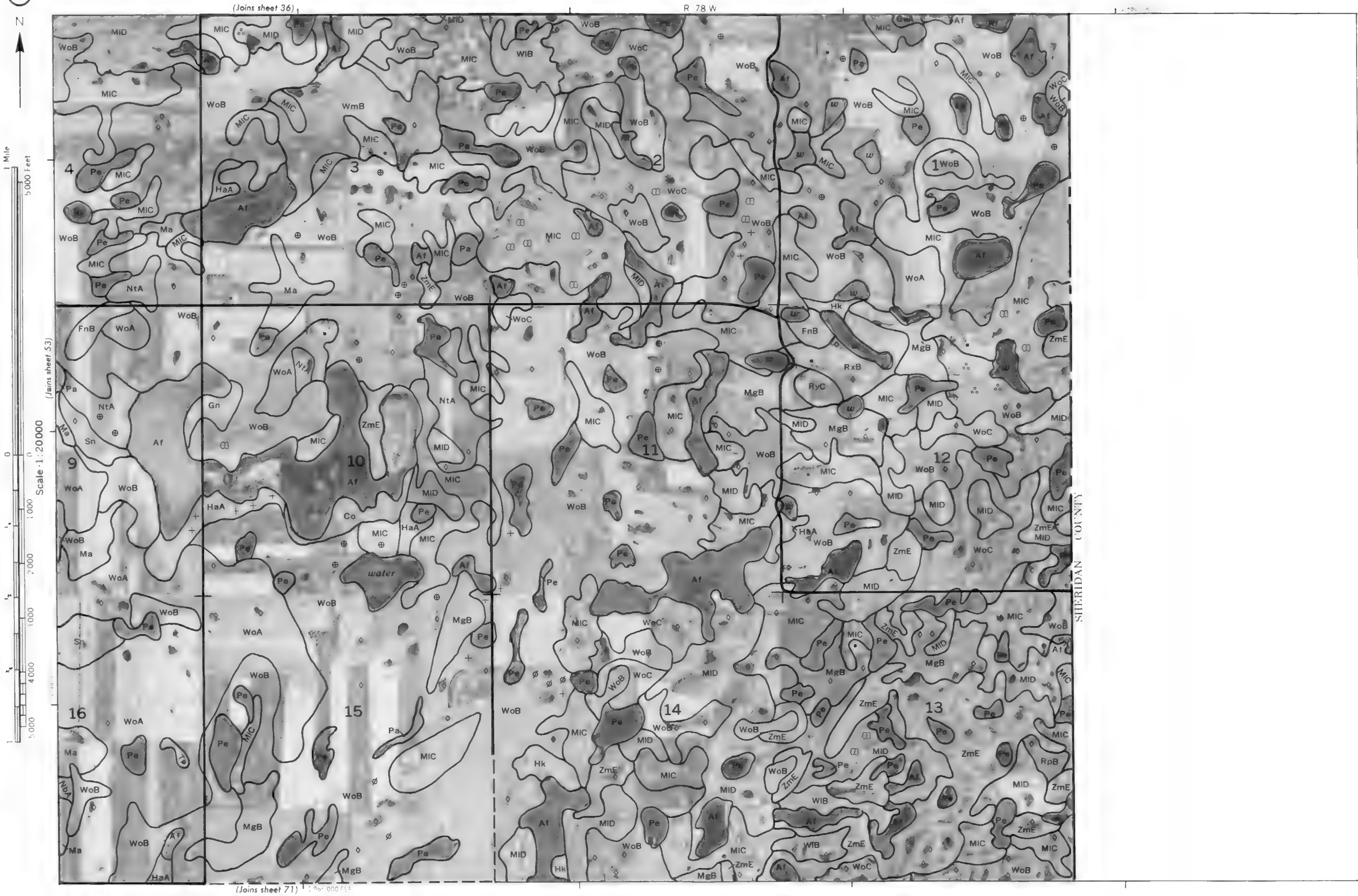
McLEAN COUNTY, NORTH DAKOTA — SHEET NUMBER 51

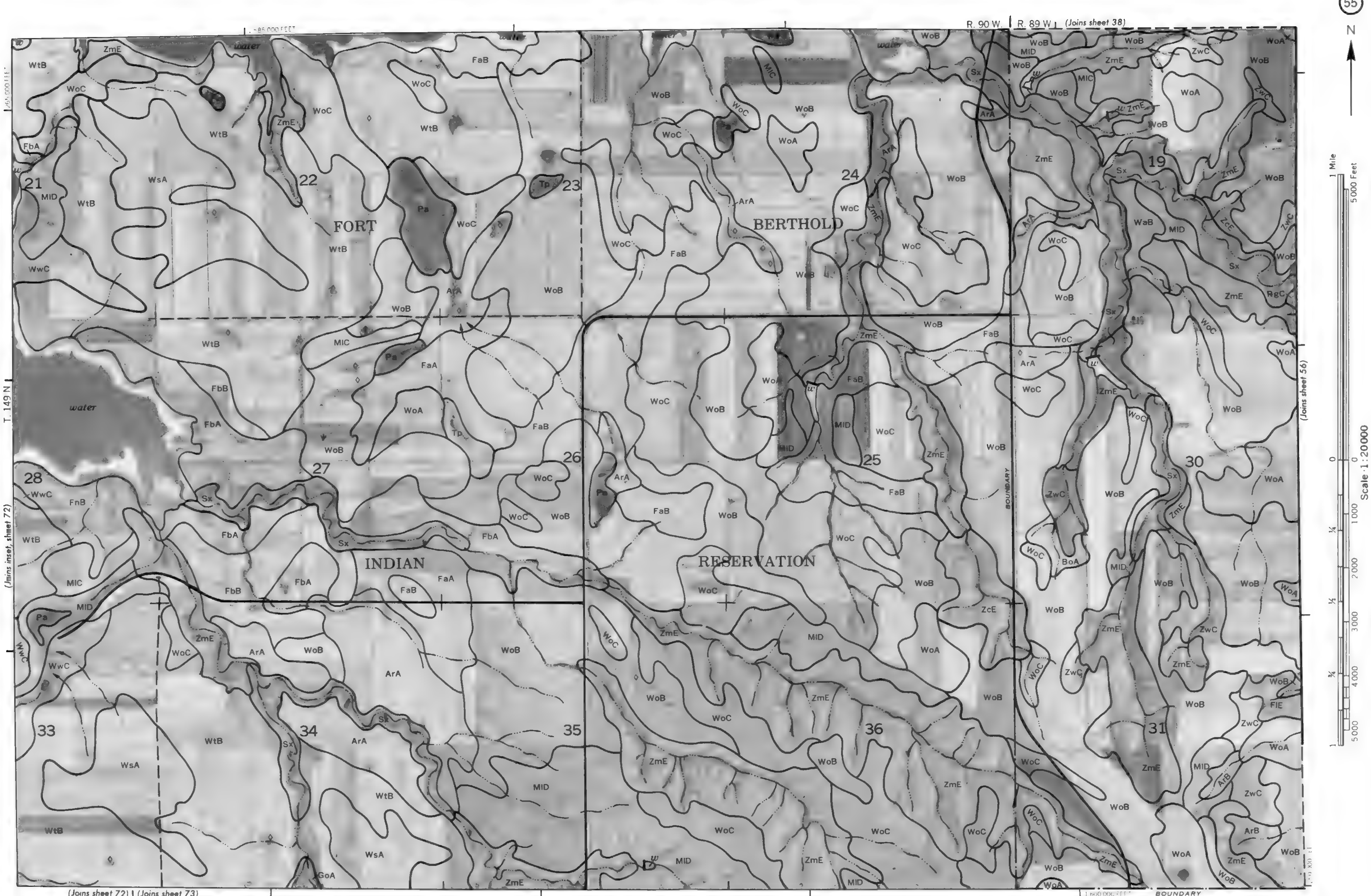


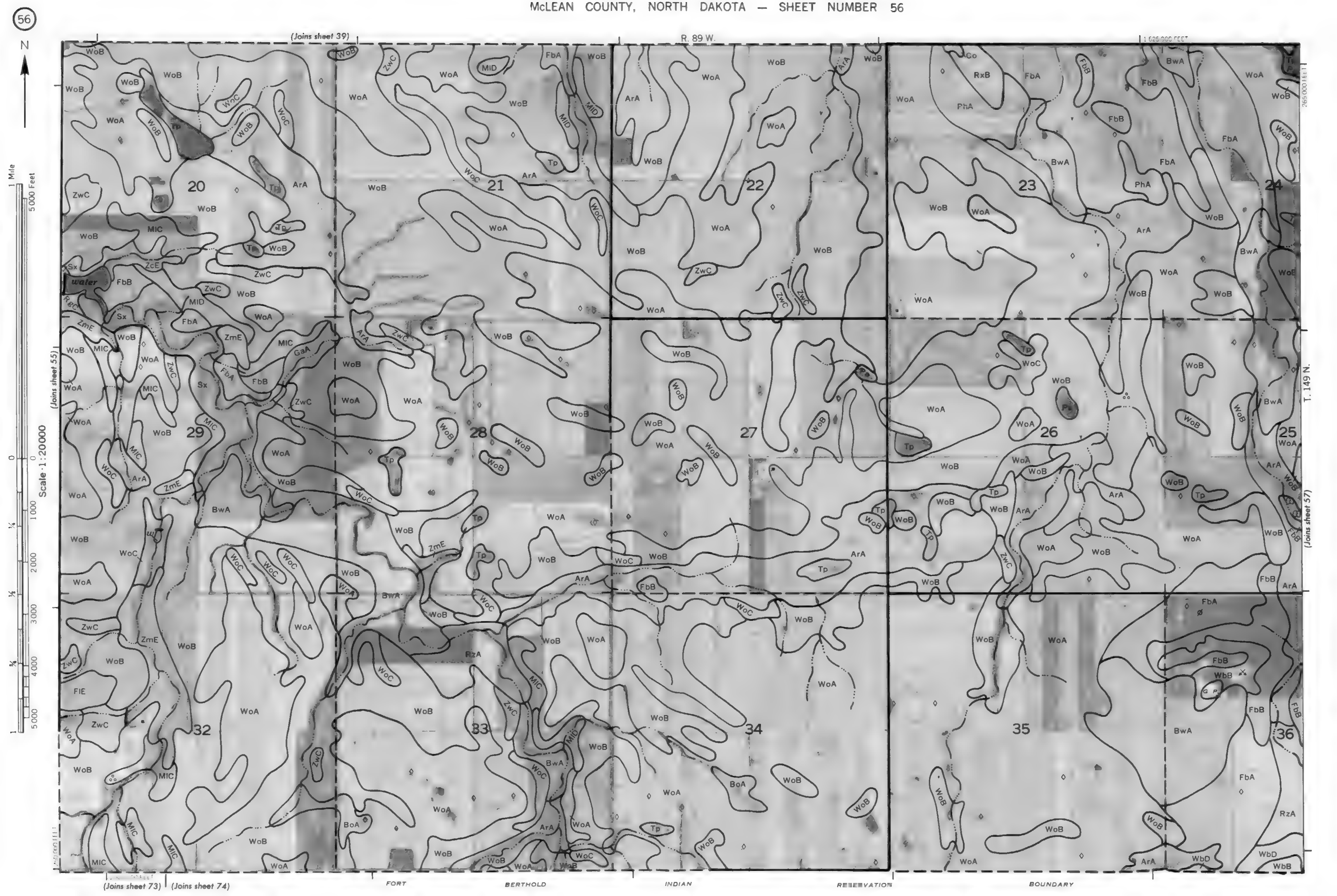
McLEAN COUNTY, NORTH DAKOTA — SHEET NUMBER 52



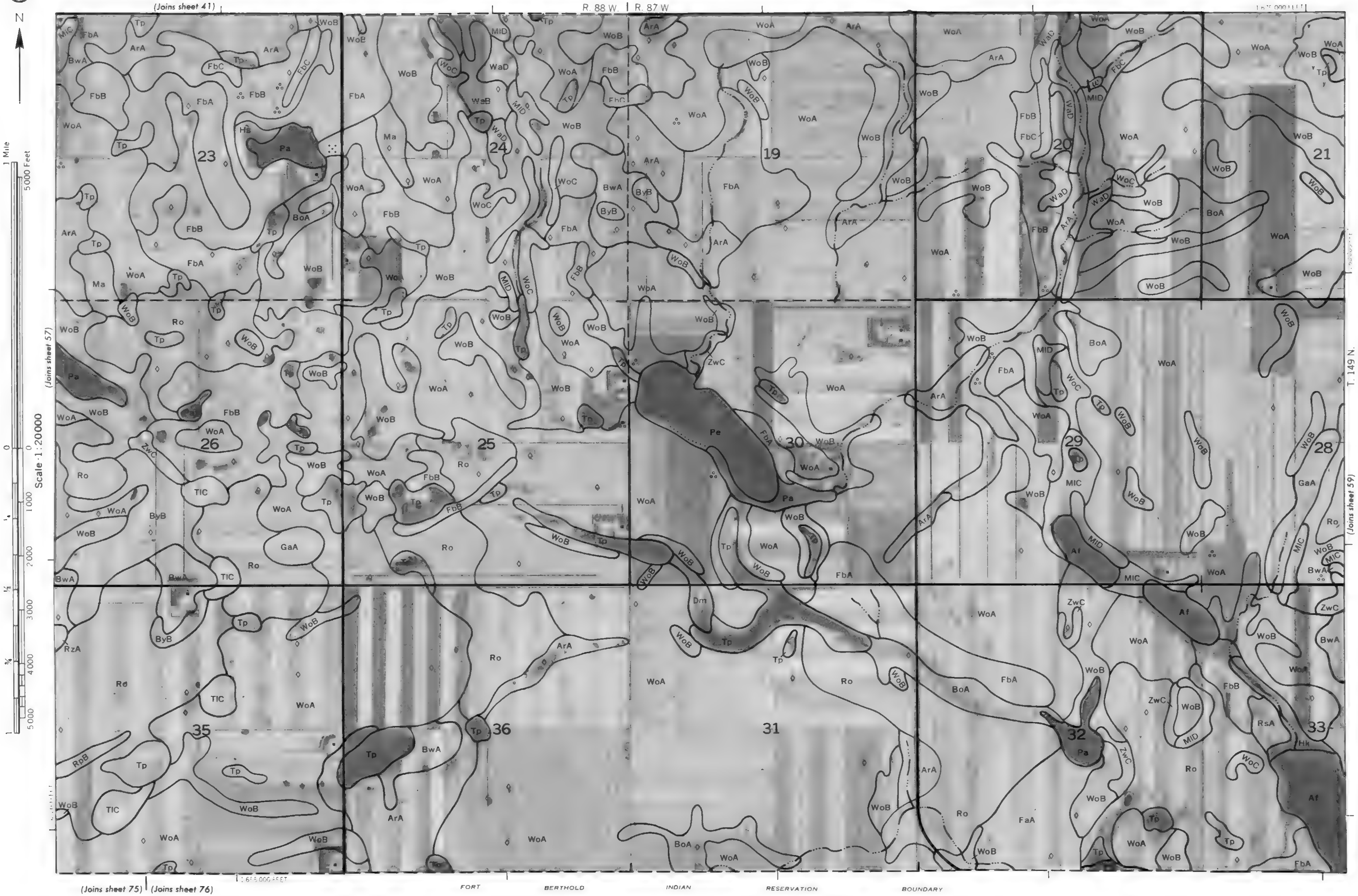

R. 79 W.
R. 78 W.
(Joins sheet 35)
(Joins sheet 54)
(Joins sheet 52)
(Joins sheet 70)
T. 149 N.
N
1 Mile
5000 Feet
Scale 1:20000
2
1
6
5
4
11
12
7
8
9
14
13
18
17
16


N
(Joins sheet 36)
R. 78 W
(Joins sheet 53)
(Joins sheet 71)
T. 149 N
SHERIDAN COUNTY
1 Mile
5 000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
water

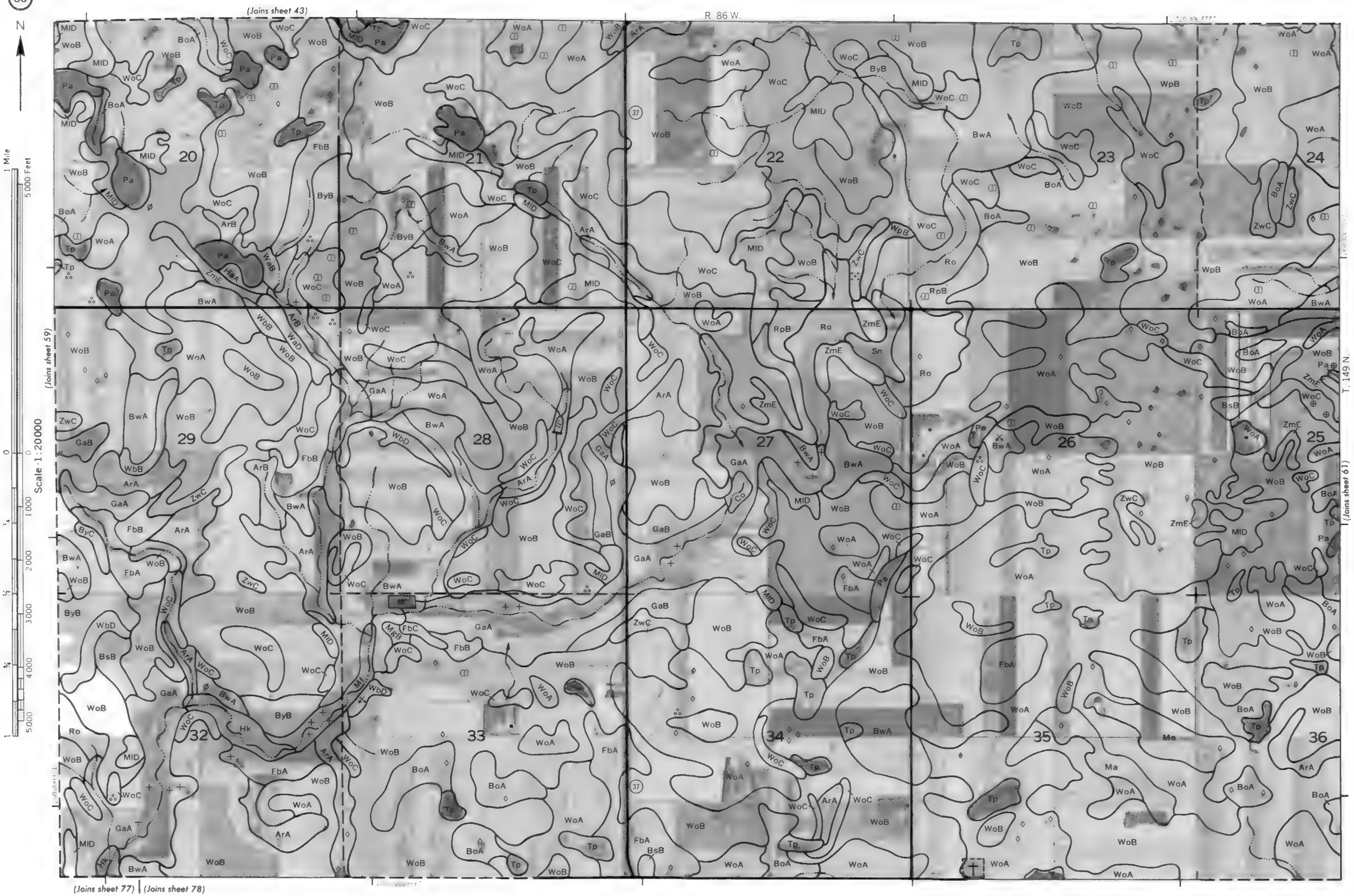

55
N
R. 90 W.
R. 89 W.
(Joins sheet 38)
(Joins sheet 56)
(Joins inset, sheet 72)
(Joins sheet 72)
(Joins sheet 73)
T. 149 N.
FORT
BERTHOLD
INDIAN
RESERVATION
BOUNDARY
water
19
21
22
23
24
25
26
27
28
30
31
33
34
35
36
1 Mile
5000 Feet
Scale 1:20000

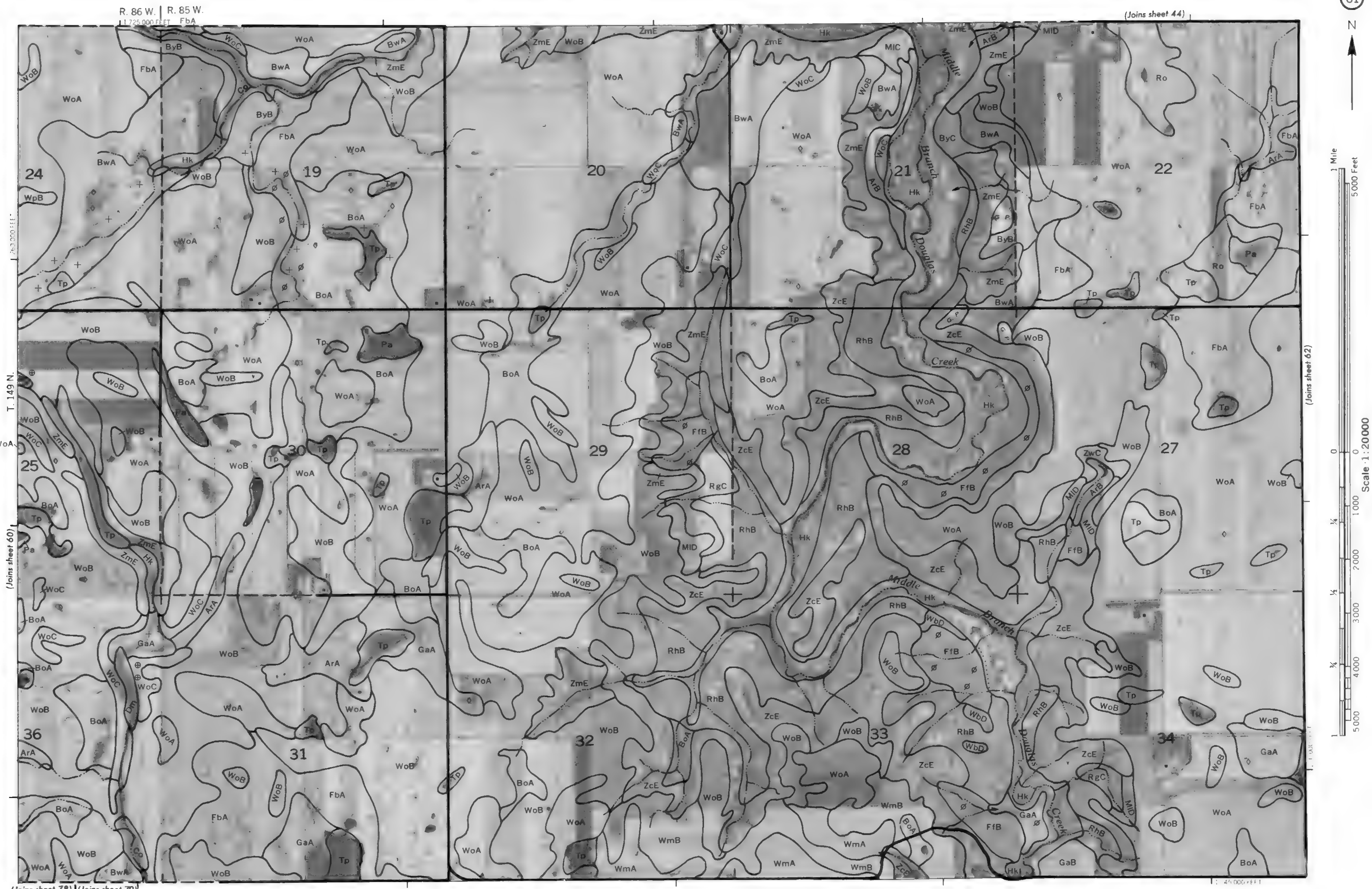

56
N
(Joins sheet 39)
R. 89 W.
(Joins sheet 55)
(Joins sheet 57)
T. 149 N.
(Joins sheet 73)
(Joins sheet 74)
FORT BERTHOLD INDIAN RESERVATION BOUNDARY
Scale 1:20000
1 Mile
5000 Feet
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36

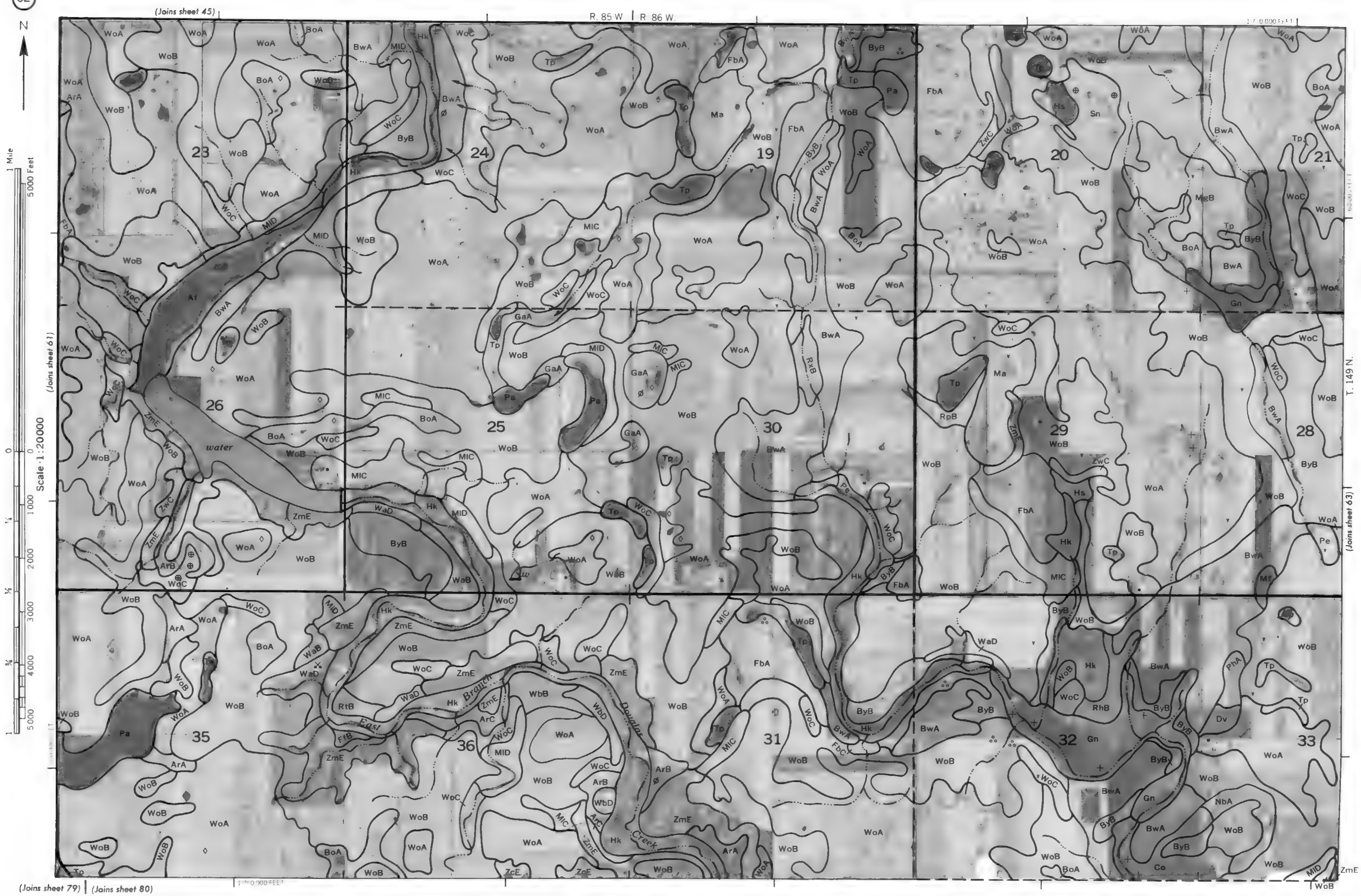

57
R. 89 W. | R. 88 W.
(Joins sheet 40)
N
T. 149 N.
(Joins sheet 56)
(Joins sheet 58)
(Joins sheet 74)
(Joins sheet 75)
FORT BERTHOLD INDIAN RESERVATION BOUNDARY
24
19
20
21
22
25
30
29
28
27
36
31
32
33
34
1 Mile
5000 Feet
Scale 1:20000
1 650 000 FEET


N
(Joins sheet 41)
R. 88 W.
R. 87 W.
(Joins sheet 57)
(Joins sheet 59)
T. 149 N.
(Joins sheet 75)
(Joins sheet 76)
FORT BERTHOLD INDIAN RESERVATION BOUNDARY
Scale 1:20000
1 Mile
5000 Feet
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33

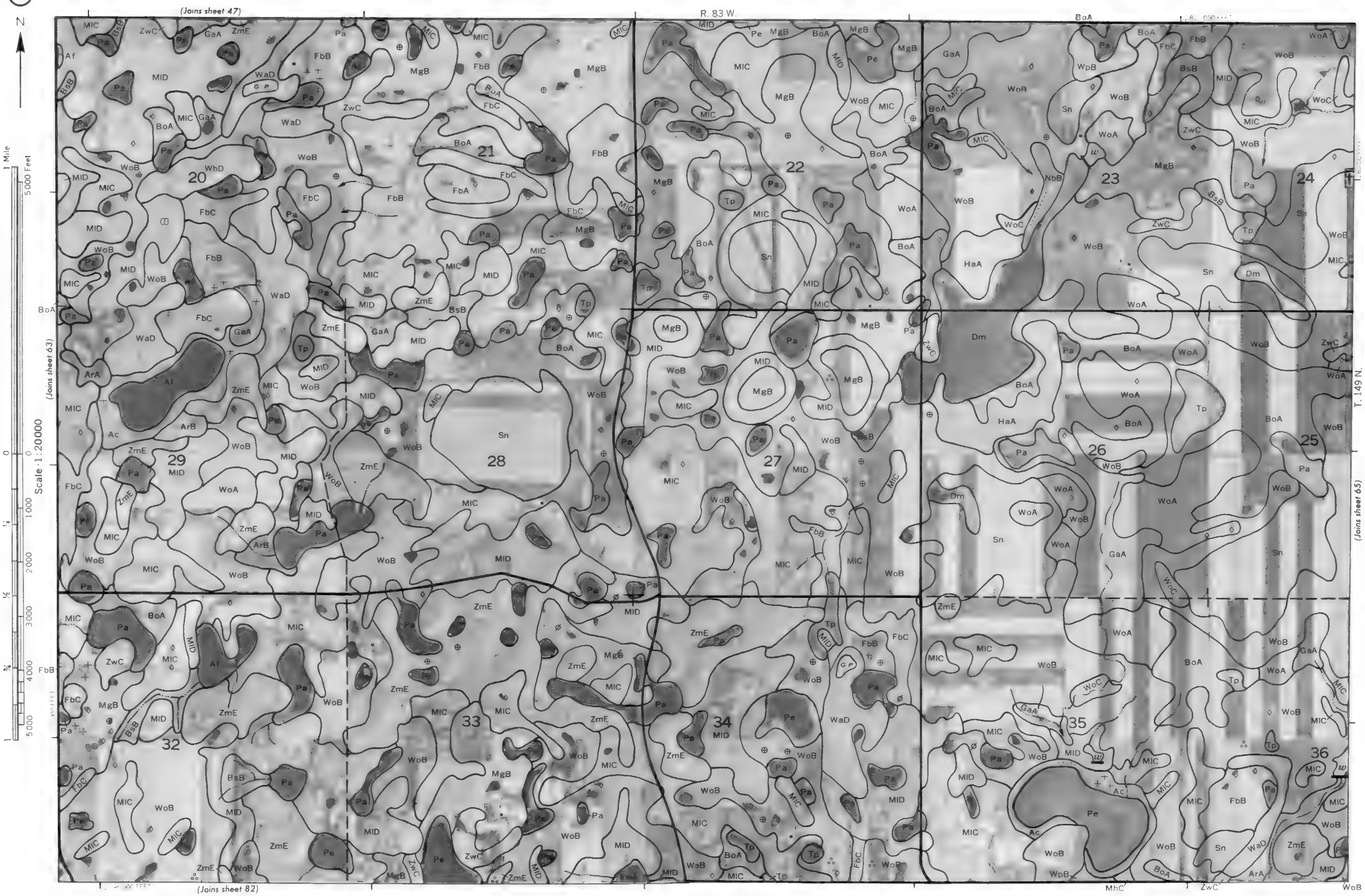

R. 87 W.
R. 86 W.
(Joins sheet 42)
N
1 680 000 FEET
T. 149 N.
(Joins sheet 58)
(Joins sheet 60)
(Joins sheet 76)
(Joins sheet 77)
1 690 000 FEET
1 Mile
5000 Feet
Scale 1:20000
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31

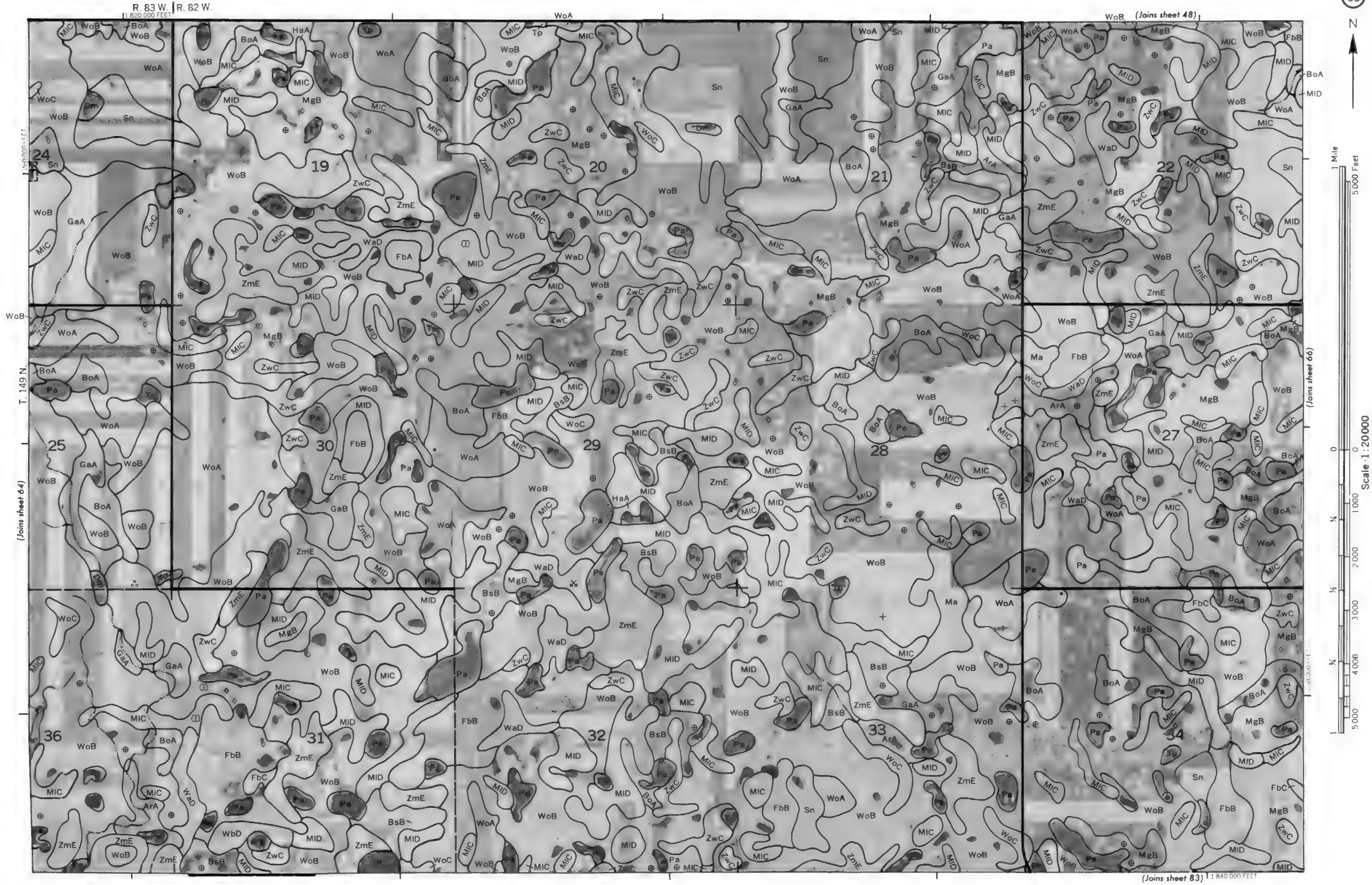

N
(Joins sheet 43)
R 86 W.
T. 149 N.
(Joins sheet 59)
(Joins sheet 61)
(Joins sheet 77)
(Joins sheet 78)
1 Mile
5 000 Feet
Scale 1:20000
20
21
22
23
24
29
28
27
26
25
32
33
34
35
36

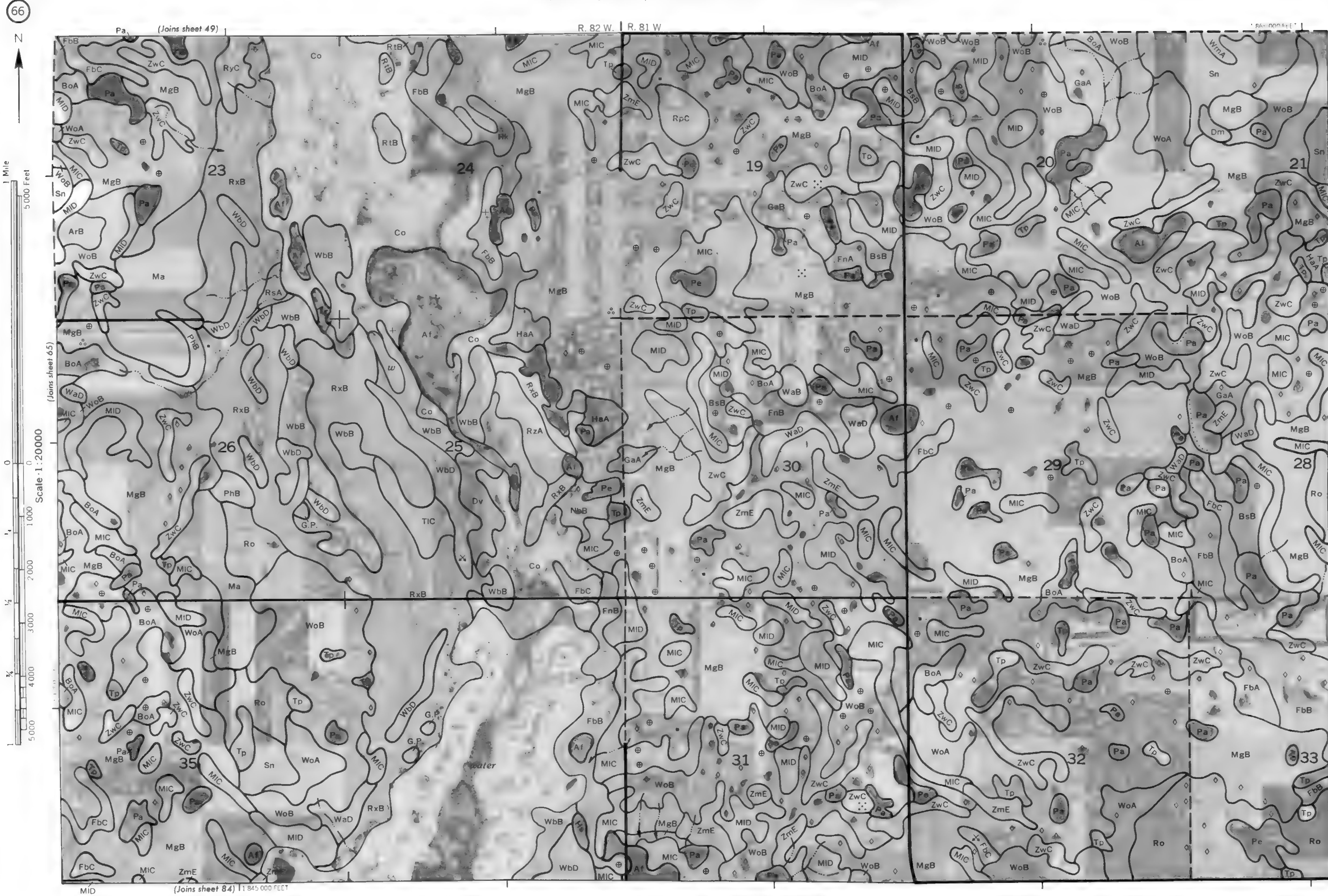

R. 86 W.
R. 85 W.
T. 149 N.
(Joins sheet 44)
(Joins sheet 62)
(Joins sheet 60)
(Joins sheet 78)
(Joins sheet 79)
N
Scale 1:20000
1 Mile
5000 Feet
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36
Middle Branch Douglas Creek
Middle Branch
Douglas Creek


N
(Joins sheet 45)
R. 85 W.
R. 86 W.
T. 149 N.
(Joins sheet 61)
(Joins sheet 63)
(Joins sheet 79)
(Joins sheet 80)
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
23
24
19
20
21
26
25
30
29
28
35
36
31
32
33
water
East Branch
Douglas Creek

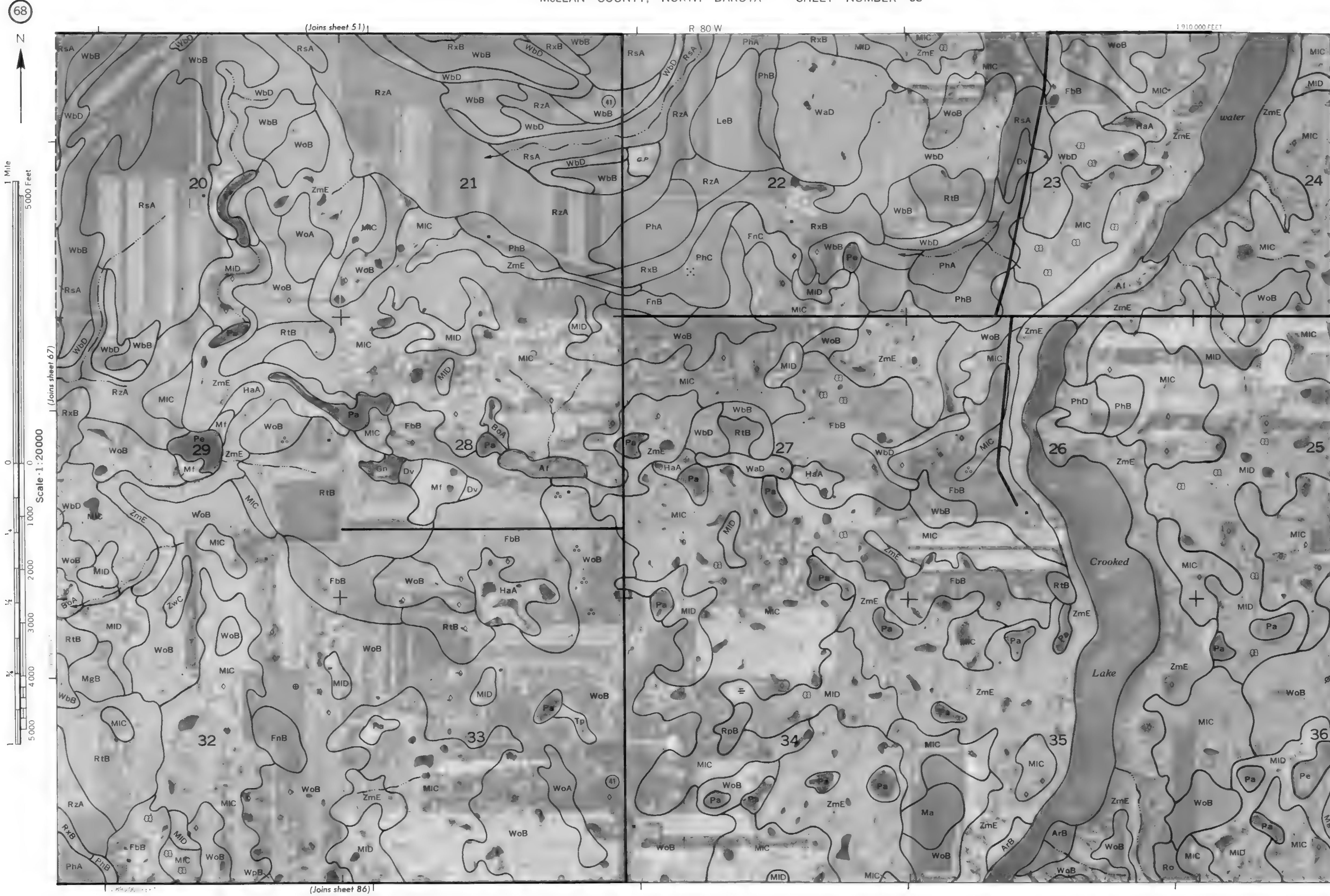

(Joins sheet 46)
R. 84 W.
R. 83 W.
N
T. 149 N.
(Joins sheet 62)
(Joins sheet 64)
(Joins sheet 81)
1 Mile
5000 Feet
Scale 1:20000
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
water

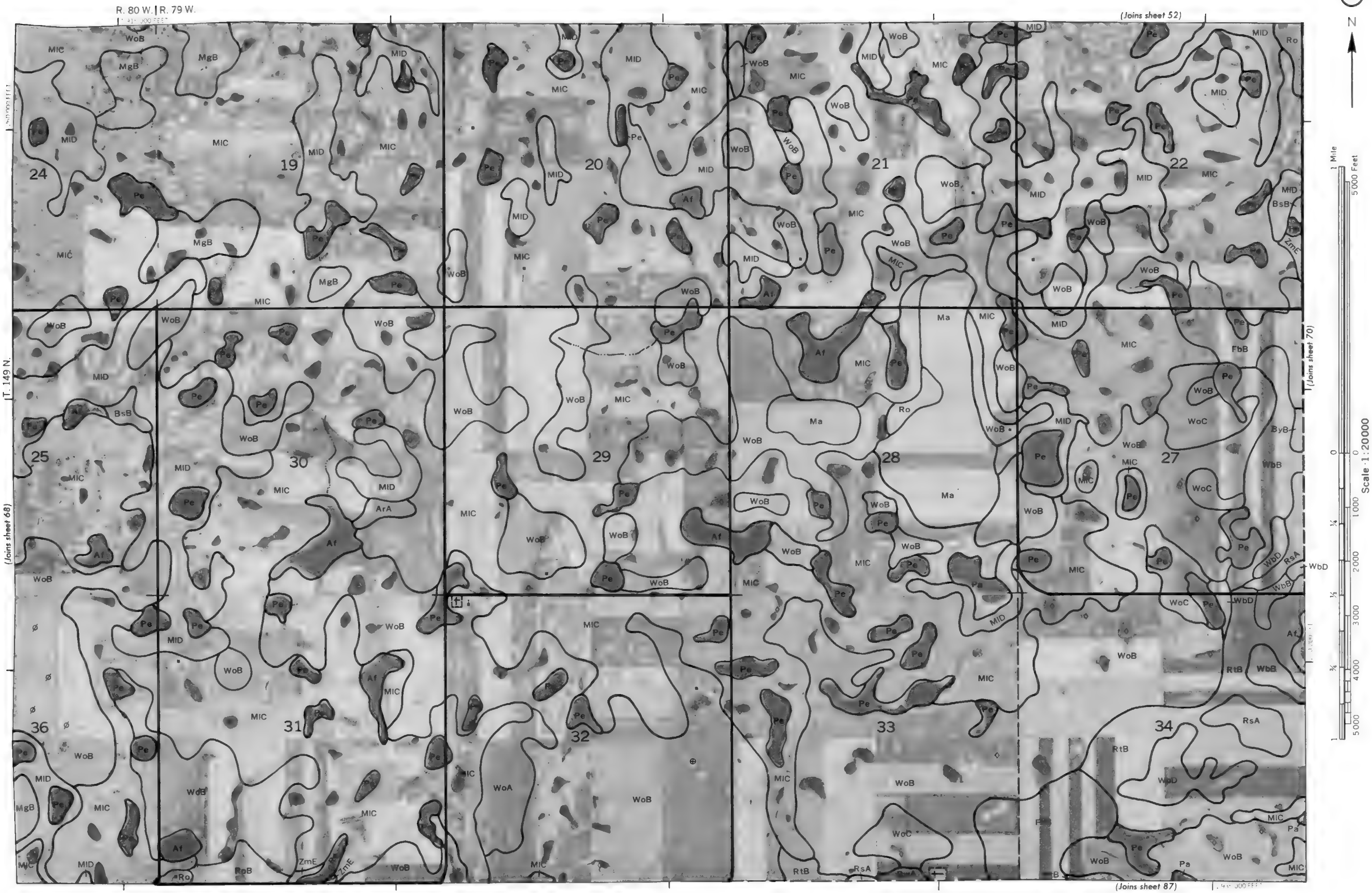

N
(Joins sheet 47)
(Joins sheet 63)
(Joins sheet 65)
(Joins sheet 82)
R. 83 W.
T. 149 N.
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36

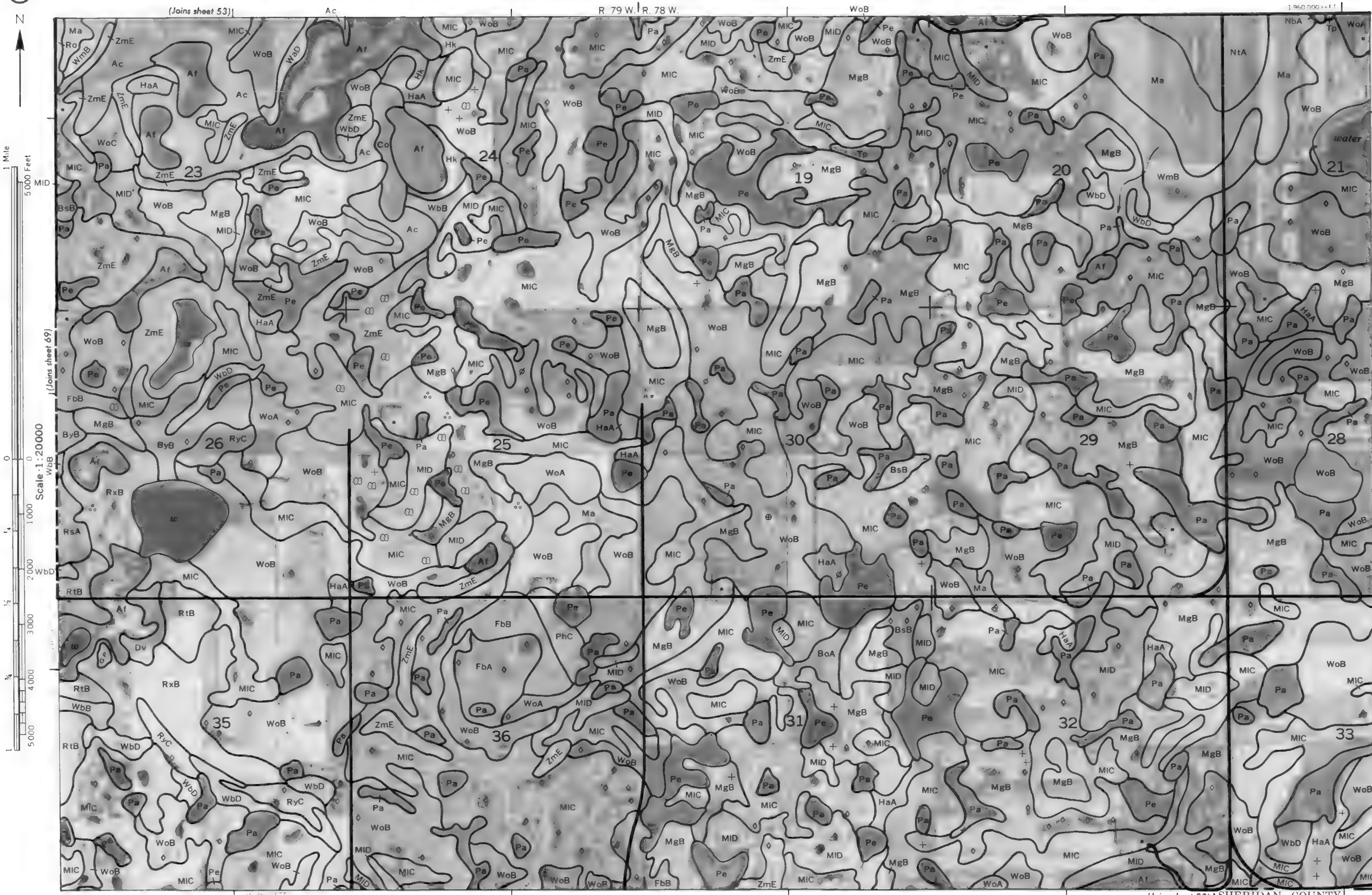

R. 83 W.
R. 82 W.
(Joins sheet 48)
(Joins sheet 66)
(Joins sheet 64)
(Joins sheet 83)
T. 149 N.
N
Scale 1:20000
1 Mile
5000 Feet
1 840 000 FEET
1 820 000 FEET

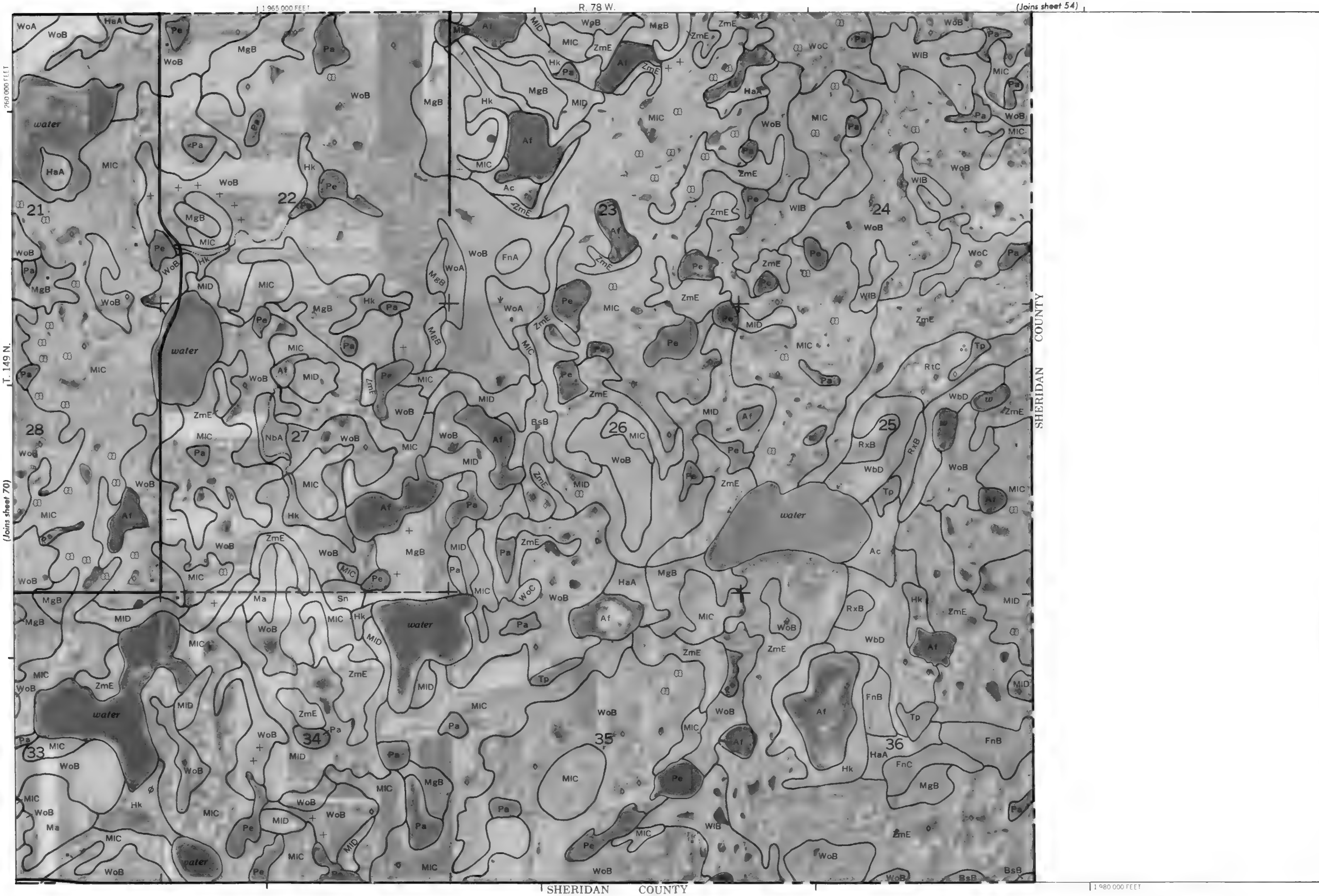

66
N
(Joins sheet 49)
R. 82 W.
R. 81 W.
(Joins sheet 65)
(Joins sheet 67)
(Joins sheet 84)
1 845 000 FEET
T. 149 N.
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
19
20
21
23
24
25
26
28
29
30
31
32
33
35
water
G.P.

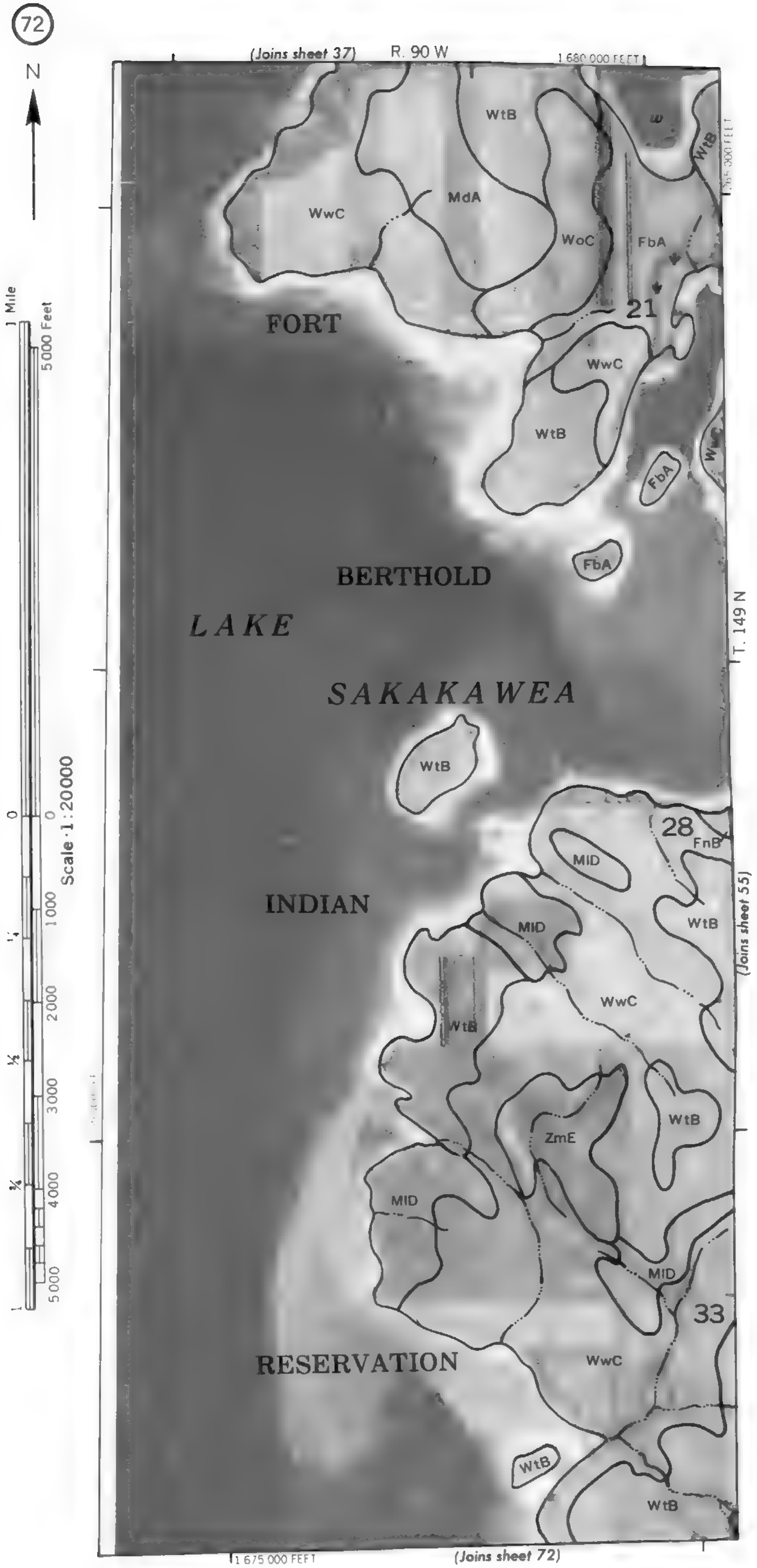

67
N
R. 81 W | R. 80 W
(Joins sheet 50)
(Joins sheet 68)
(Joins sheet 66)
(Joins sheet 85)
T. 149 N.
870 000 FEET
260 000 FEET
1 885 000 FEET
1 Mile
5000 Feet
Scale 1:20000
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31


N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
(Joins sheet 51)
R 80 W
1 910 000 FEET
(Joins sheet 67)
(Joins sheet 69)
T. 149 N.
(Joins sheet 86)
20
21
22
23
24
29
28
27
26
25
32
33
34
35
36
water
Crooked
Lake

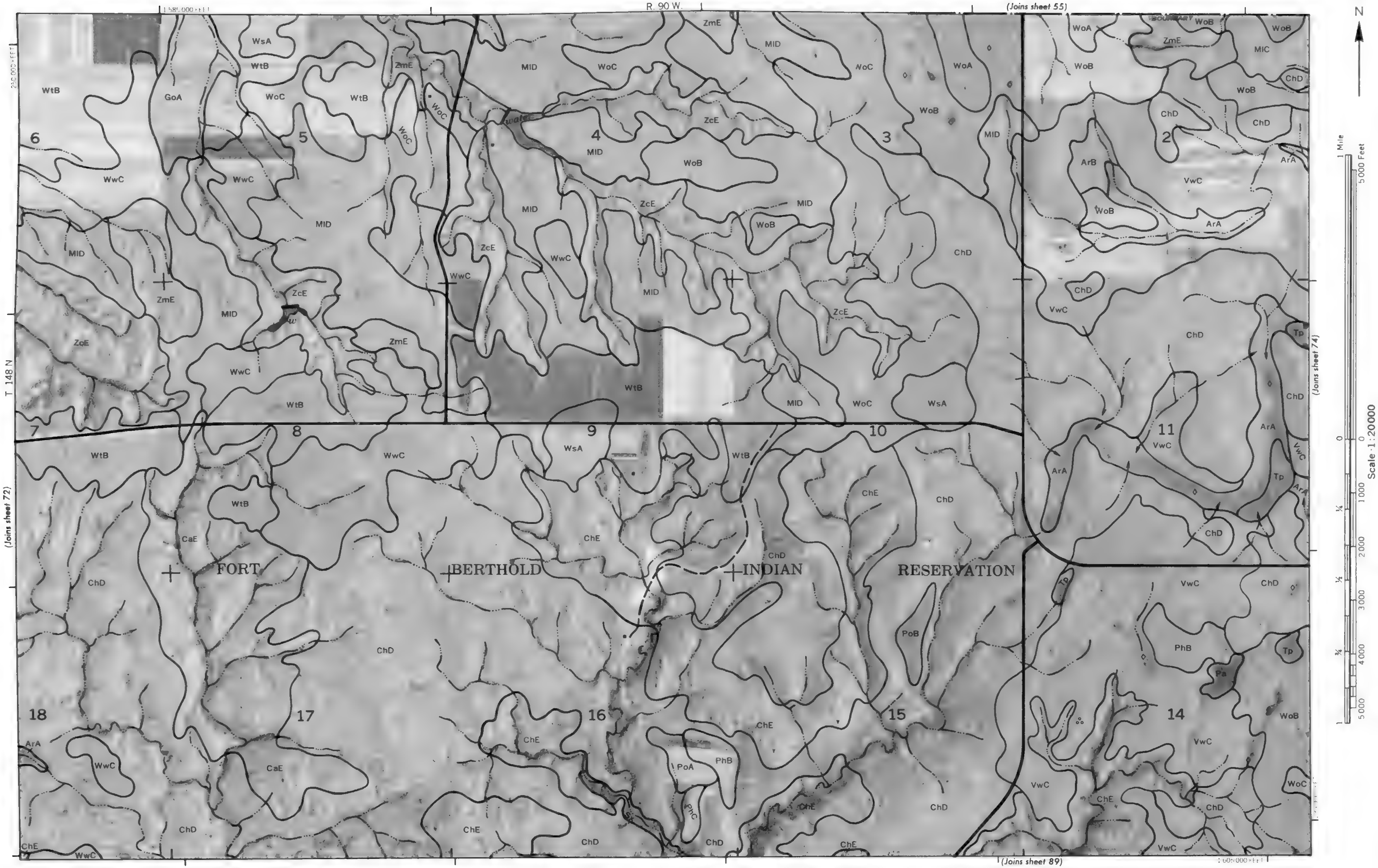

R. 80 W. | R. 79 W.
T. 149 N.
(Joins sheet 52)
(Joins sheet 68)
(Joins sheet 70)
(Joins sheet 87)
24
19
20
21
22
25
30
29
28
27
36
31
32
33
34
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1


N
(Joins sheet 53)
R. 79 W.
R. 78 W.
T. 149 N.
(Joins sheet 69)
(Joins sheet 71)
(Joins sheet 88)
SHERIDAN COUNTY
Scale 1:20000
1 Mile
5 000 Feet
19
20
21
23
24
25
26
28
29
30
31
32
33
35
36
water

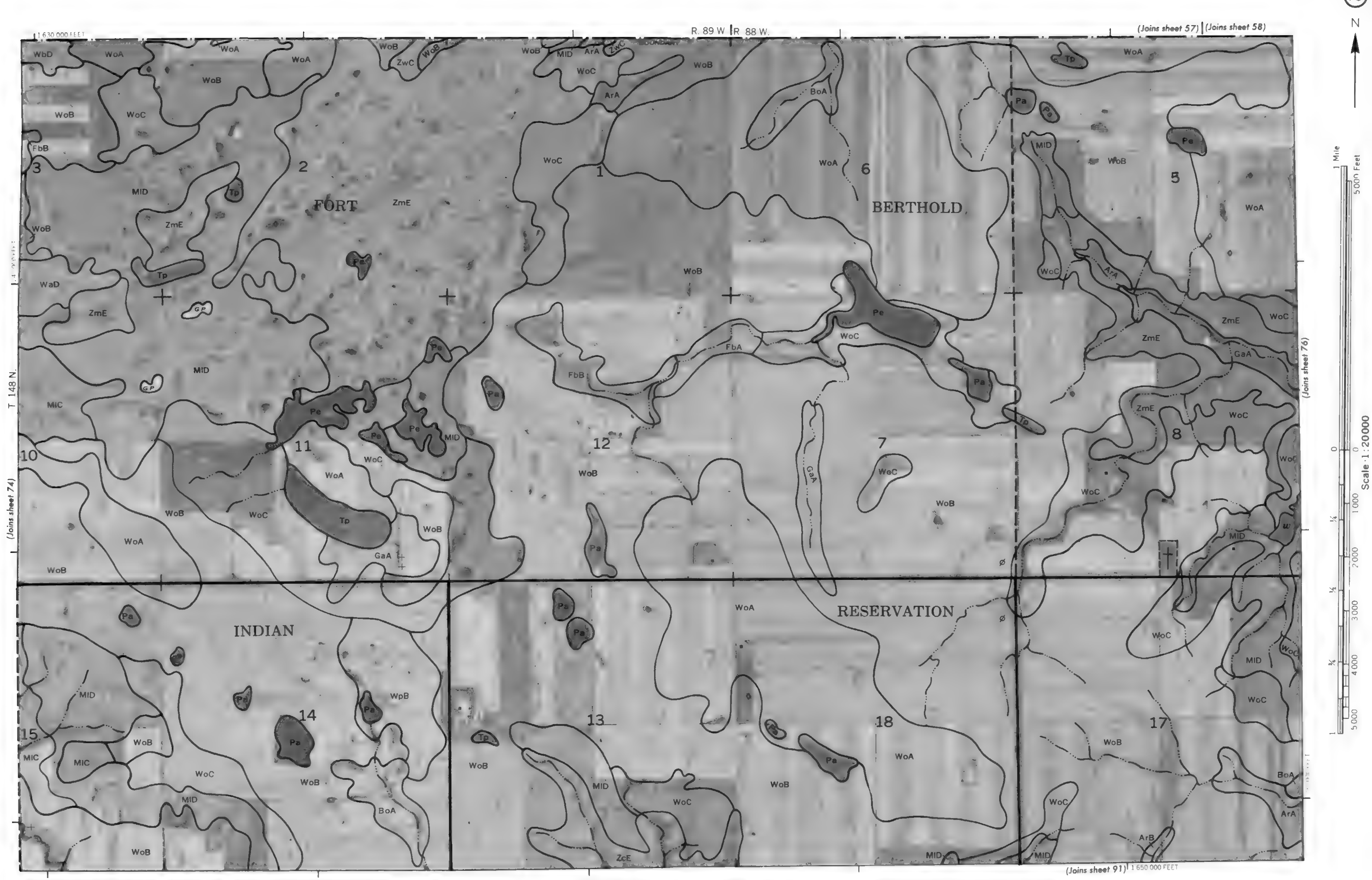

1 965 000 FEET
R. 78 W.
(Joins sheet 54)
260 000 FEET
T. 149 N.
(Joins sheet 70)
SHERIDAN COUNTY
SHERIDAN COUNTY
1 980 000 FEET
21
22
23
24
25
26
27
28
33
34
35
36
water

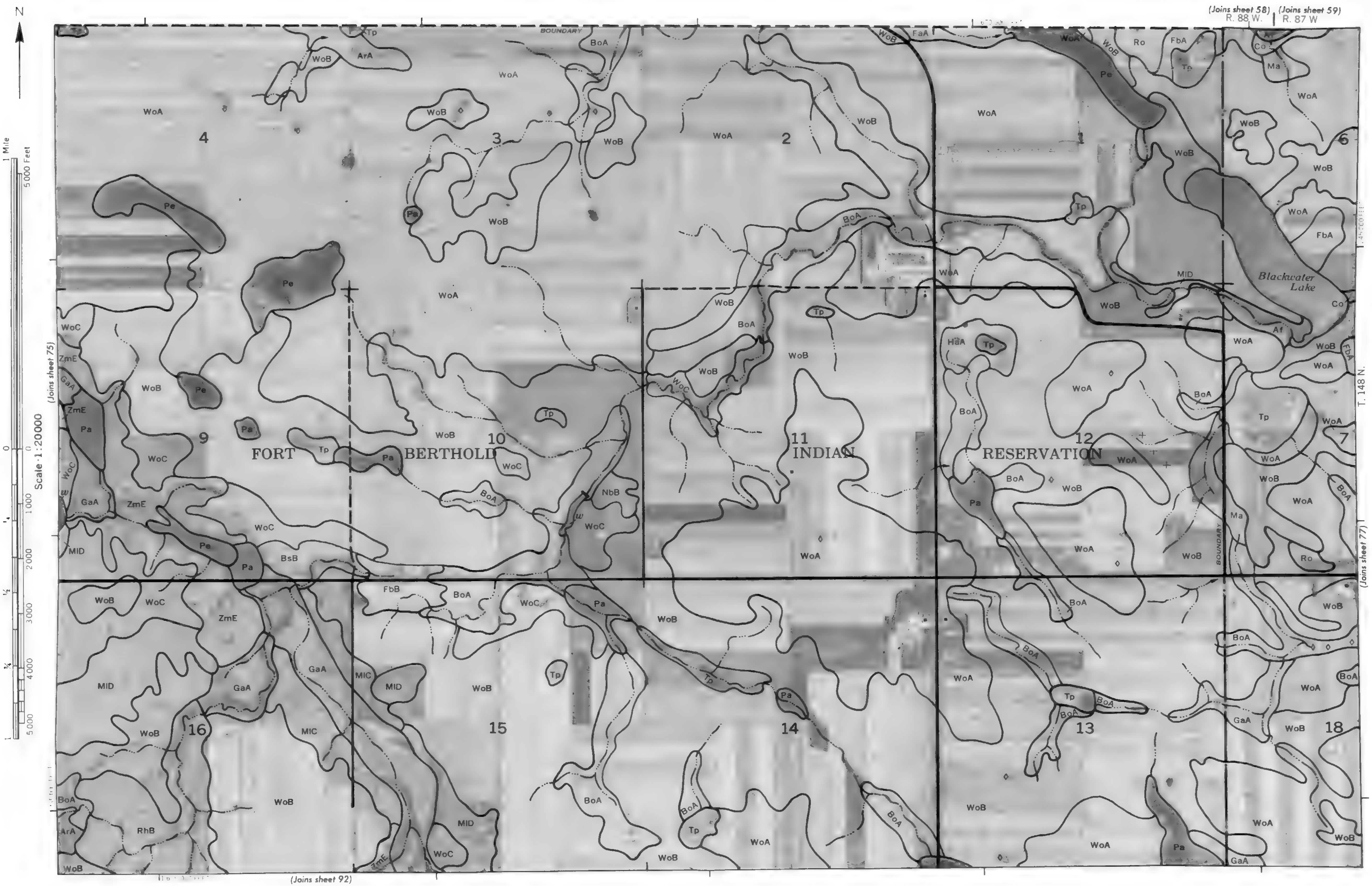

72
N
1 Mile
5000 Feet
0
Scale 1:20000
1000
2000
3000
4000
5000
(Joins sheet 37)
R. 90 W.
1 680 000 FEET
T. 149 N.
(Joins sheet 55)
(Joins sheet 72)
1 675 000 FEET
FORT
BERTHOLD
LAKE
SAKAKAWEA
INDIAN
RESERVATION
WtB
WwC
MdA
WoC
FbA
21
28
33
FnB
MlD
ZmE

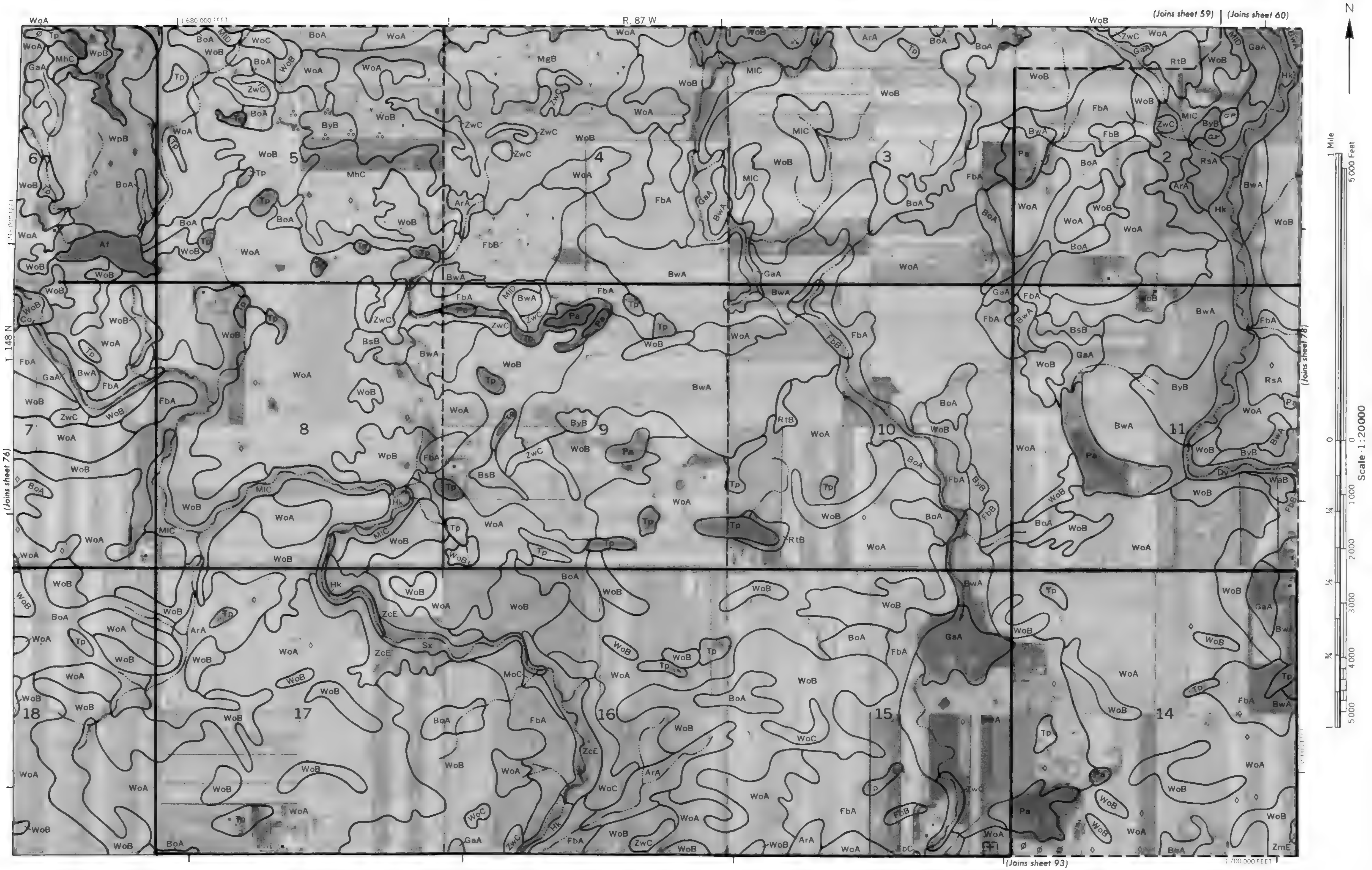

(Joins sheet 72)
(Joins sheet 55)
R. 92 W.
R. 91 W.
T. 148 N.
(Joins sheet 73)
(Joins sheet 89)
LAKE
SAKAKAWEA
FORT
BERTHOLD
INDIAN
RESERVATION
6
7
12
13
14
18
WwC
WtB
ArA
MlD
ZmE
FfB
ZcE
CaE
ChD
ChE

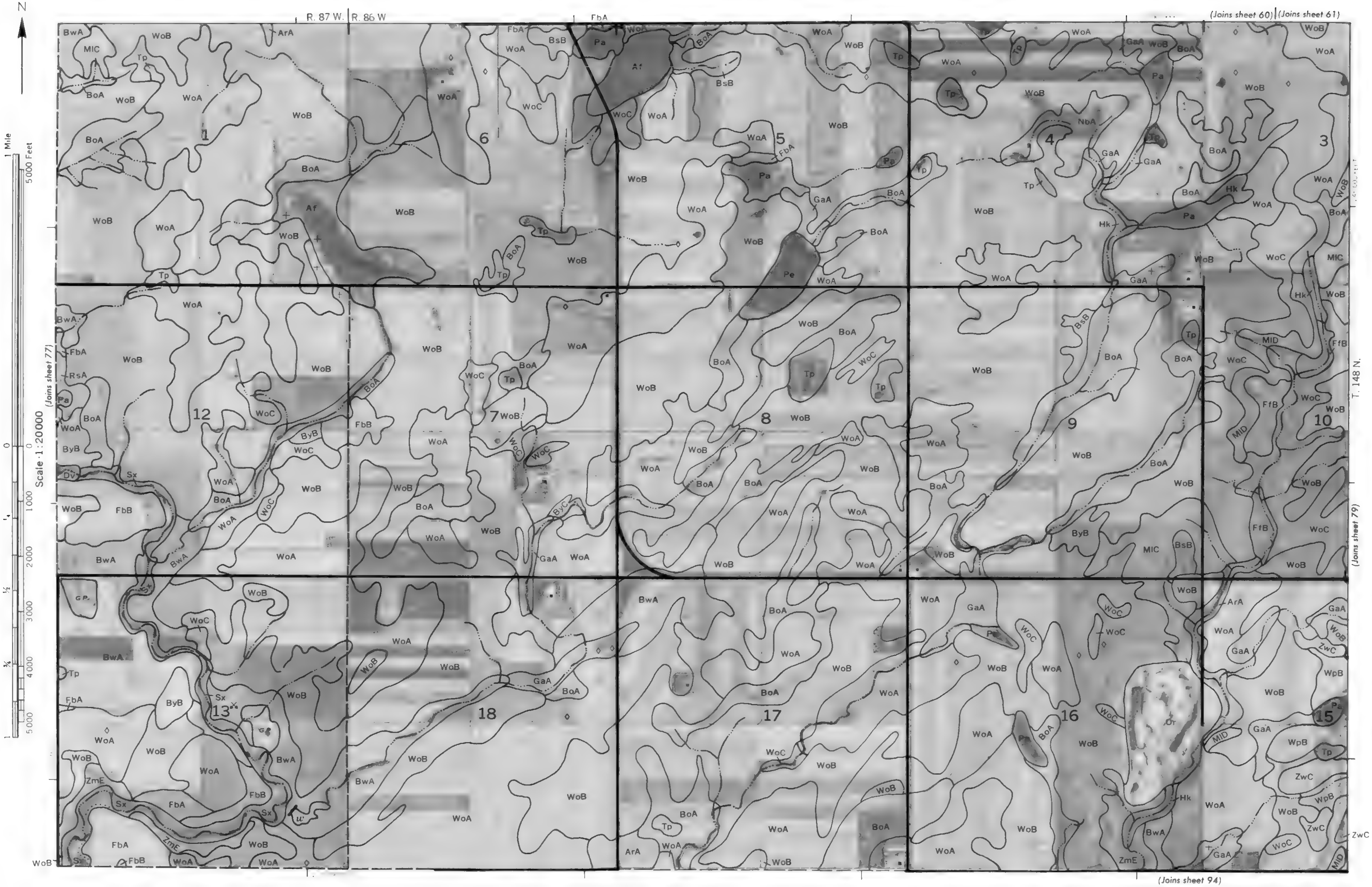

73
N
R. 90 W.
(Joins sheet 55)
(Joins sheet 72)
(Joins sheet 74)
(Joins sheet 89)
T 148 N
FORT BERTHOLD INDIAN RESERVATION
1 Mile
5000 Feet
Scale 1:20000

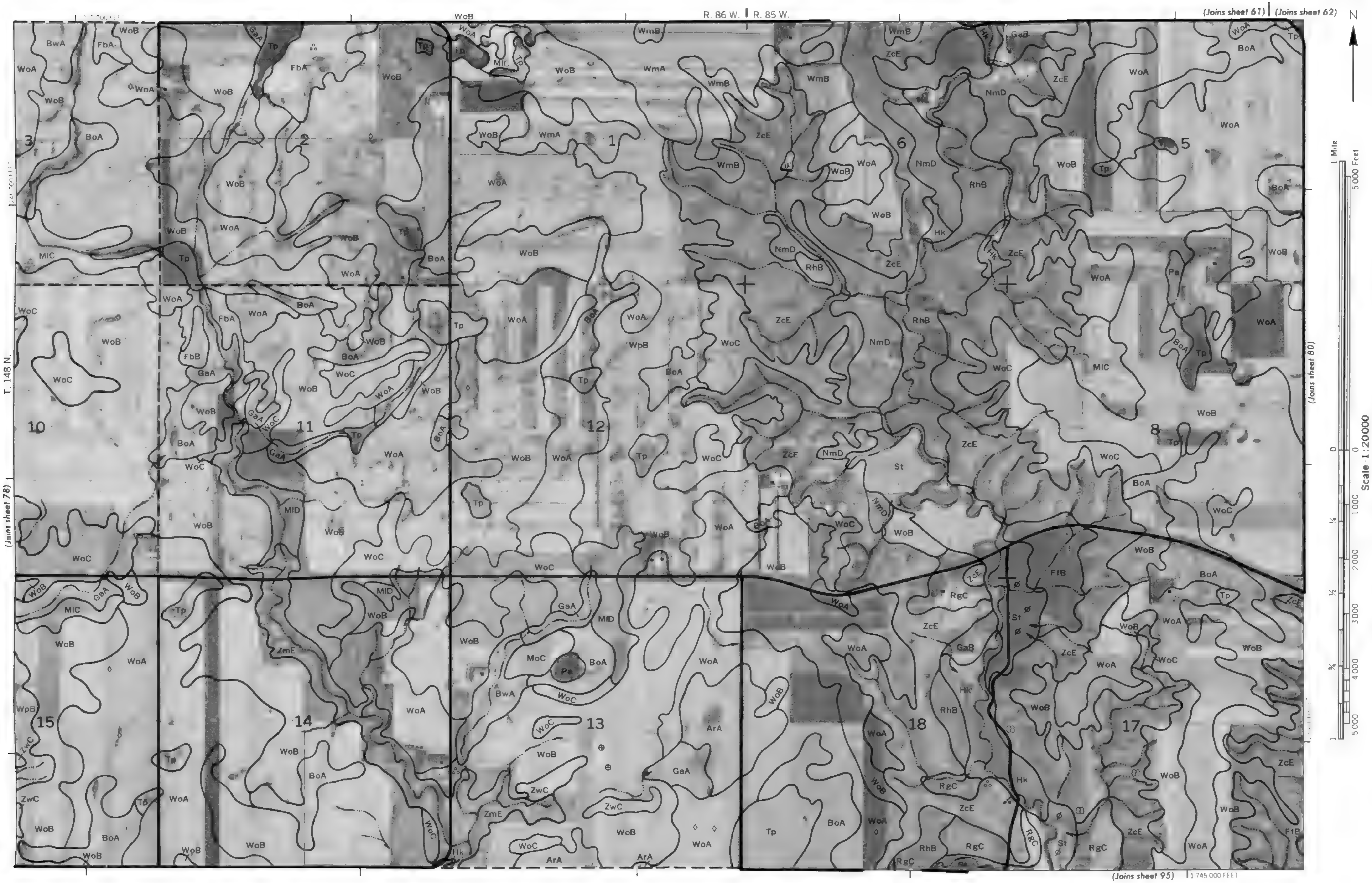

N
R. 90 W
R. 89 W
BOUNDARY
(Joins sheet 56)
(Joins sheet 57)
(Joins sheet 73)
(Joins sheet 75)
(Joins sheet 90)
T 148 N
1 Mile
5 000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
FORT
BERTHOLD
INDIAN
RESERVATION
1
3
4
5
6
7
8
9
10
12
13
15
16
17
18

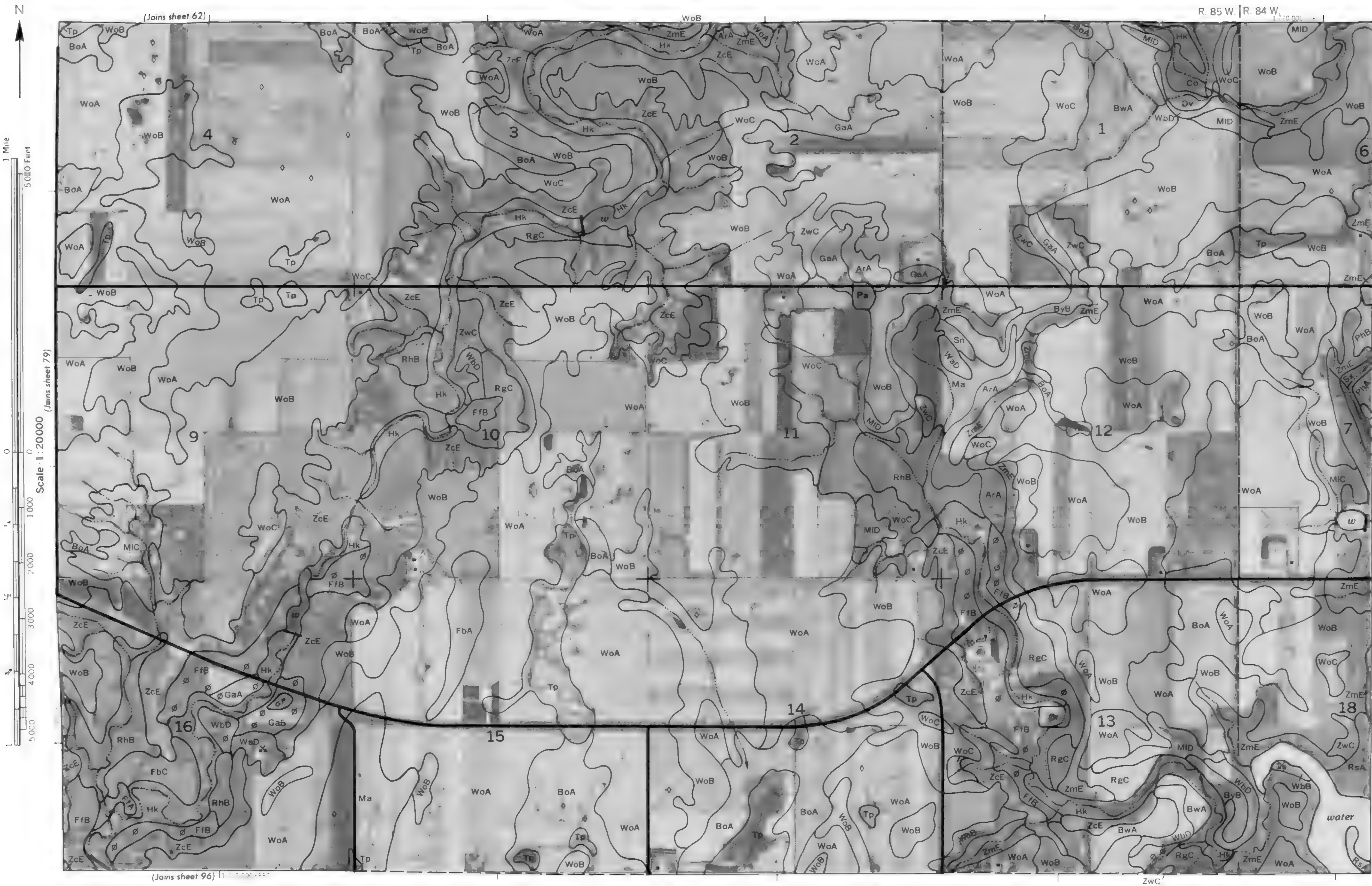

75
N
R. 89 W
R. 88 W.
(Joins sheet 57)
(Joins sheet 58)
(Joins sheet 74)
(Joins sheet 76)
(Joins sheet 91)
T 148 N.
FORT
BERTHOLD
INDIAN
RESERVATION
1
2
3
5
6
7
8
10
11
12
13
14
15
17
18
WoA
WoB
WoC
WbD
WaD
ZwC
MID
MIC
ArA
ArB
BoA
FbB
FbA
ZmE
ZcE
Tp
Pa
Pe
GaA
GP
WpB
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000

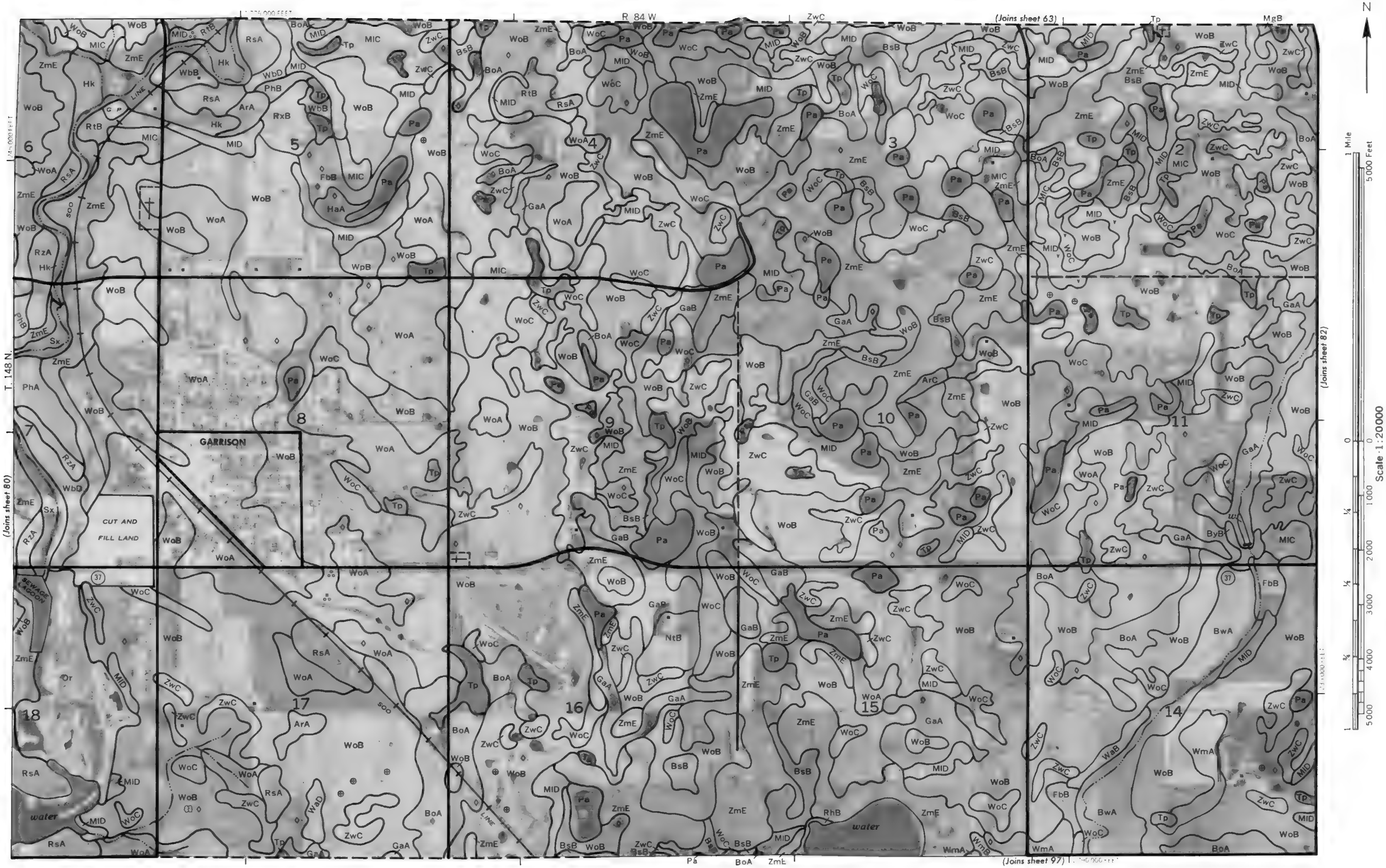

N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 58)
(Joins sheet 59)
R. 88 W.
R. 87 W
BOUNDARY
(Joins sheet 75)
(Joins sheet 77)
(Joins sheet 92)
T. 148 N.
FORT BERTHOLD INDIAN RESERVATION
Blackwater Lake
2
3
4
6
7
9
10
11
12
13
14
15
16
18
WoA
WoB
WoC
Pe
Pa
Tp
BoA
ArA
FaA
FbA
FbB
Ro
Co
Ma
MID
MIC
ZmE
GaA
BsB
NbB
HaA
Af
RhB


77
N
1 680 000 FEET
R. 87 W.
(Joins sheet 59)
(Joins sheet 60)
T. 148 N.
(Joins sheet 76)
(Joins sheet 78)
(Joins sheet 93)
1 700 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1/4
1/2
3/4
1
1000
2000
3000
4000
5000
6
5
4
3
2
7
8
9
10
11
18
17
16
15
14

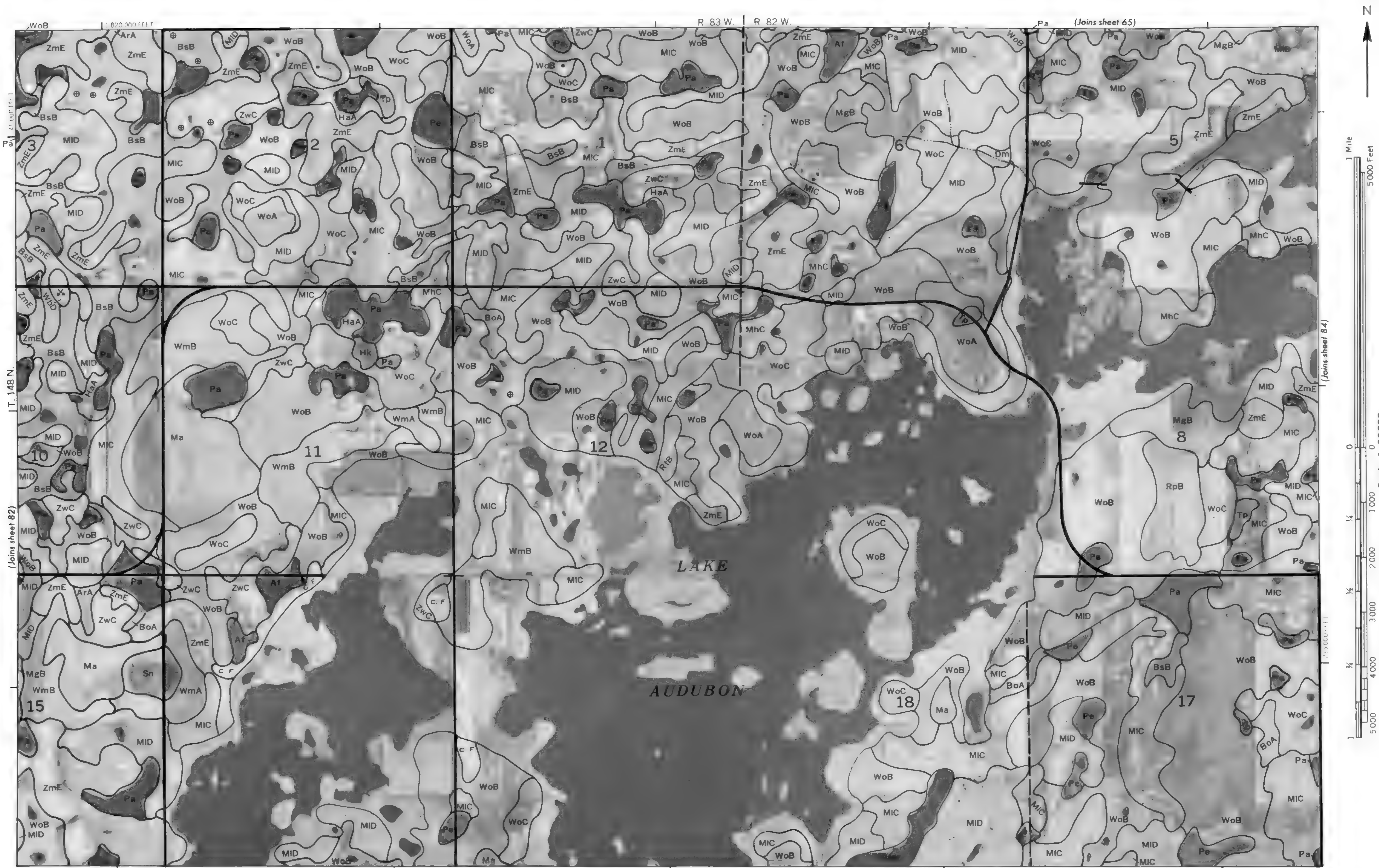

N
R. 87 W.
R. 86 W.
(Joins sheet 60)
(Joins sheet 61)
(Joins sheet 77)
(Joins sheet 79)
(Joins sheet 94)
T. 148 N.
1 Mile
5000 Feet
Scale 1:20000
1
3
4
5
6
7
8
9
10
12
13
15
16
17
18

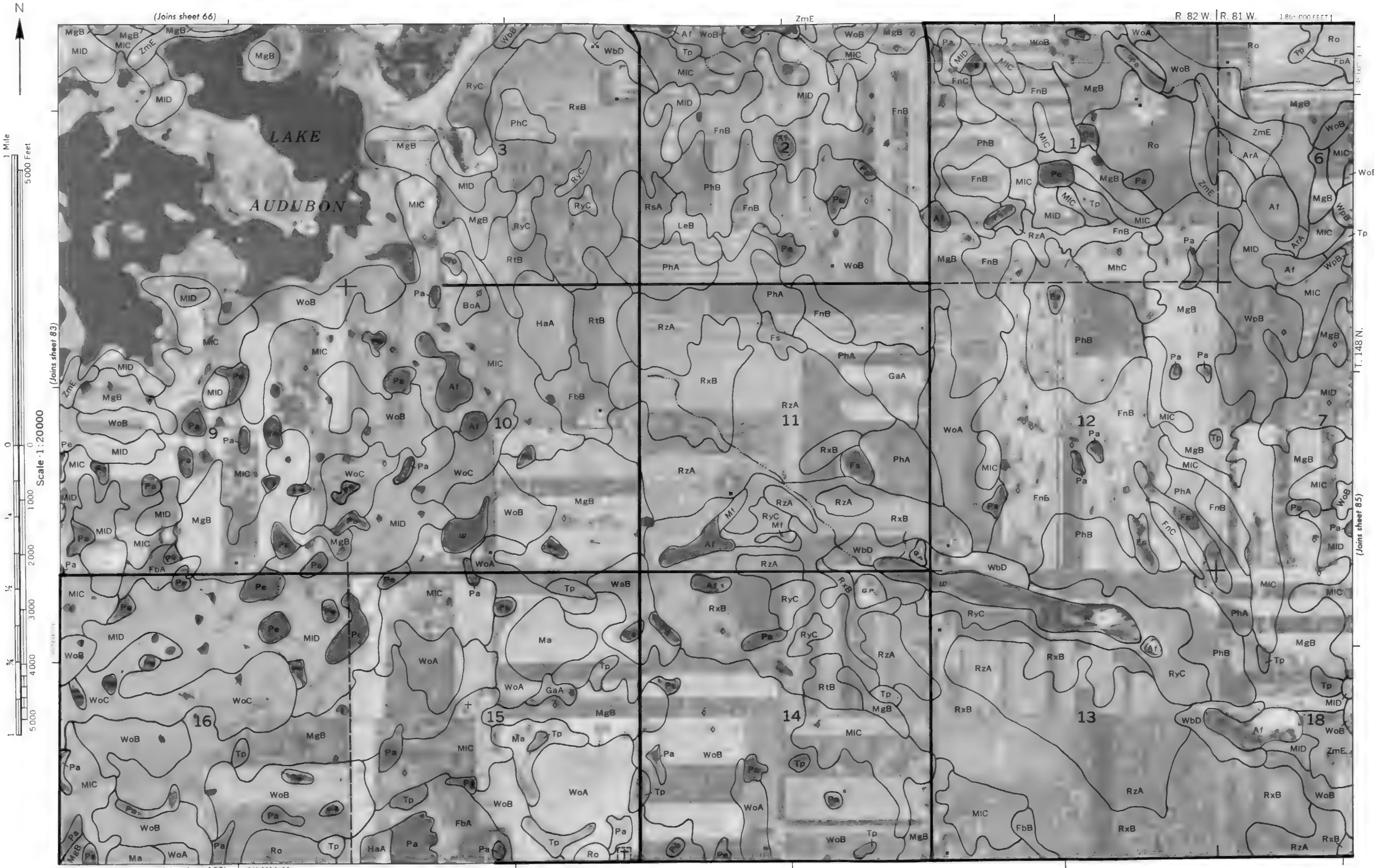

R. 86 W. | R. 85 W.
(Joins sheet 61) | (Joins sheet 62)
N
T. 148 N.
(Joins sheet 78)
(Joins sheet 80)
(Joins sheet 95)
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
1 745 000 FEET

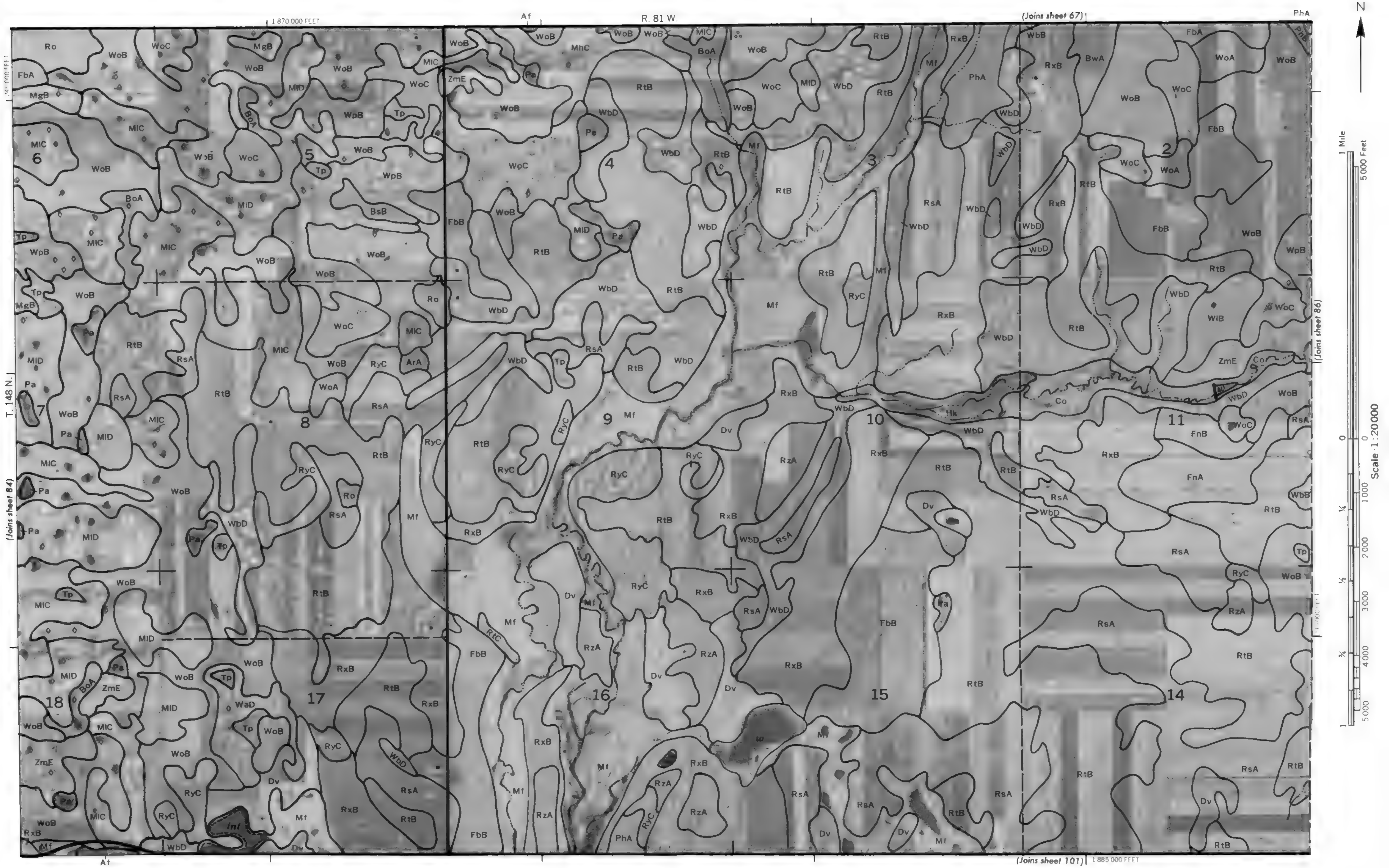

N
(Joins sheet 62)
R. 85 W.
R. 84 W.
(Joins sheet 79)
(Joins sheet 81)
(Joins sheet 96)
T. 148 N.
1 Mile
5000 Feet
Scale 1:20000
1
2
3
4
6
7
9
10
11
12
13
14
15
16
18
water

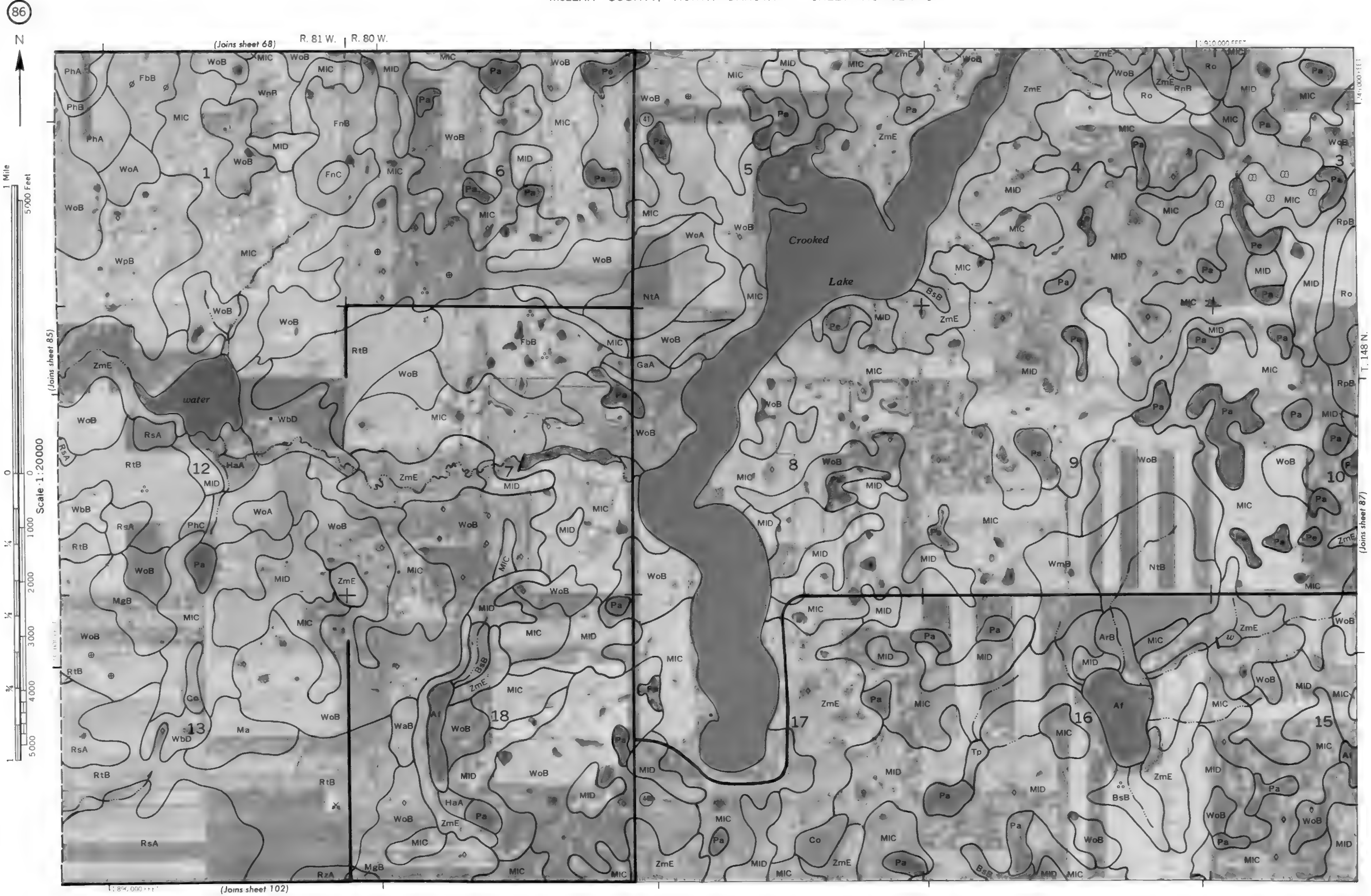

N
R 84 W
(Joins sheet 63)
(Joins sheet 82)
(Joins sheet 97)
(Joins sheet 80)
T. 148 N.
GARRISON
CUT AND FILL LAND
SEWAGE LAGOON
SOO LINE
water
1 Mile
5000 Feet
Scale 1:20000
1000
2000
3000
4000
5000
37
1
2
3
4
5
6
7
8
9
10
11
14
15
16
17
18


N
(Joins sheet 64)
R. 84 W.
R. 83 W.
1 815 000 FEET
T. 148 N.
(Joins sheet 81)
(Joins sheet 83)
(Joins sheet 98)
Scale 1:20000
1 Mile
5000 Feet
1
2
3
4
5
6
7
8
9
10
12
13
15
16
17
18


N
(Joins sheet 65)
(Joins sheet 84)
(Joins sheet 99)
(Joins sheet 82)
R. 83 W.
R. 82 W.
T. 148 N.
1 820 000 FEET
1 840 000 FEET
LAKE
AUDUBON
1
2
3
5
6
8
10
11
12
15
17
18
Scale 1:20000
1 Mile
5000 Feet
0
1/4
1/2
3/4
1
1000
2000
3000
4000
5000

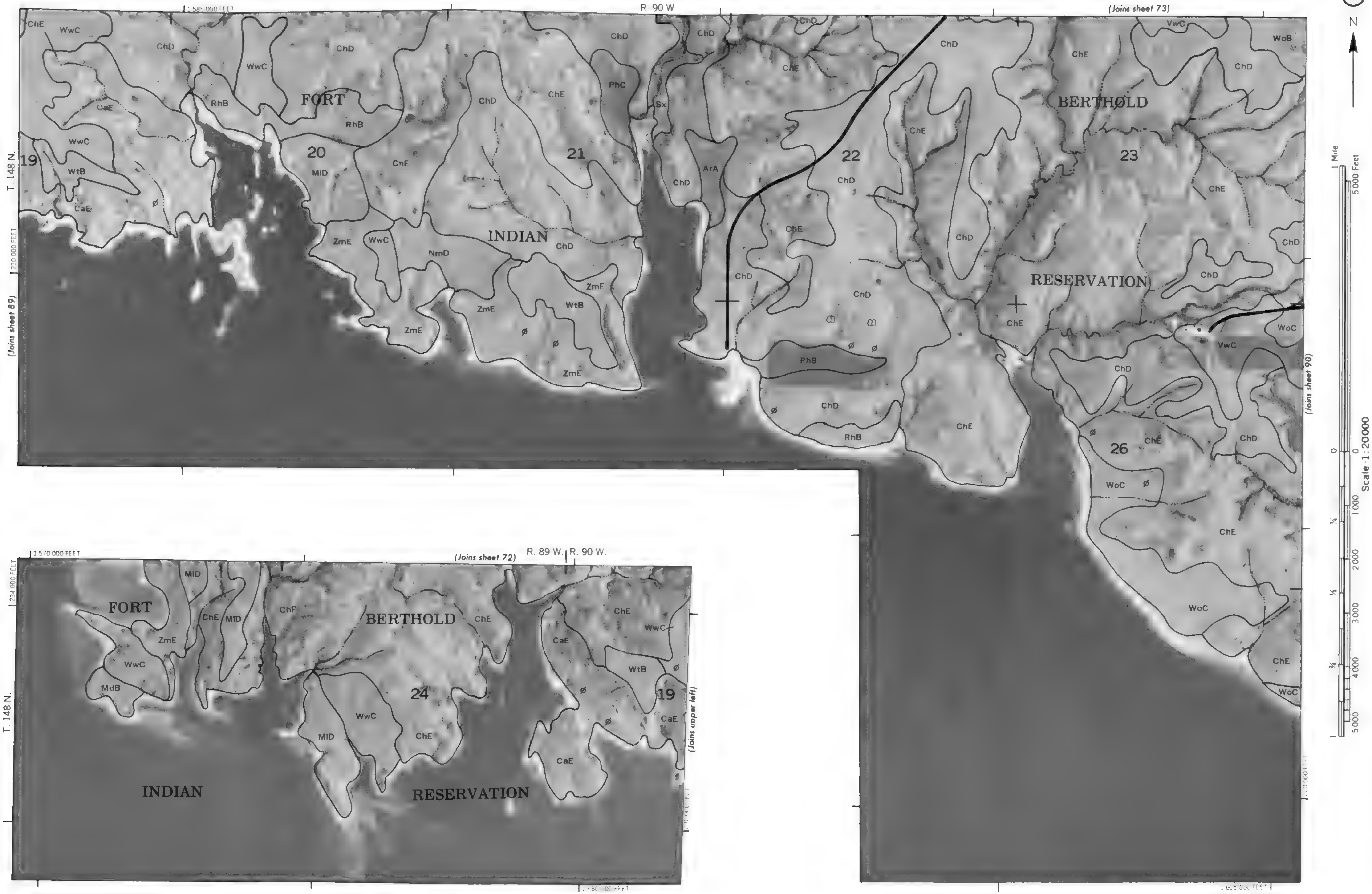

N
(Joins sheet 66)
(Joins sheet 83)
(Joins sheet 85)
(Joins sheet 100)
LAKE
AUDUBON
R. 82 W.
R. 81 W.
T. 148 N.
1 860 000 FEET
845 000 FEET
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
1
2
3
6
7
9
10
11
12
13
14
15
16
18

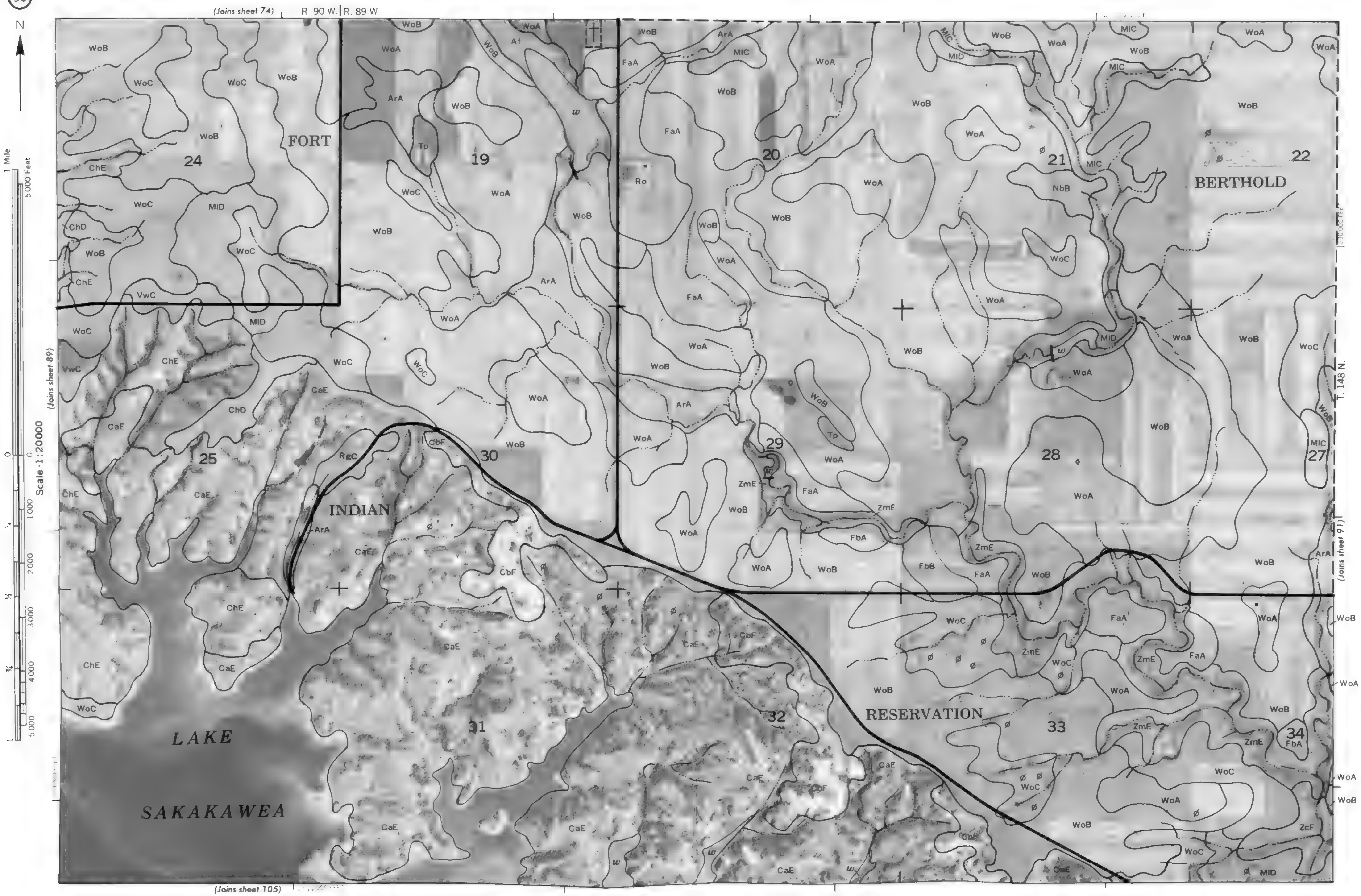

85
N
R. 81 W.
T. 148 N.
(Joins sheet 67)
(Joins sheet 84)
(Joins sheet 86)
(Joins sheet 101)
1 870 000 FEET
1 885 000 FEET
1 Mile
5000 Feet
Scale 1:20000

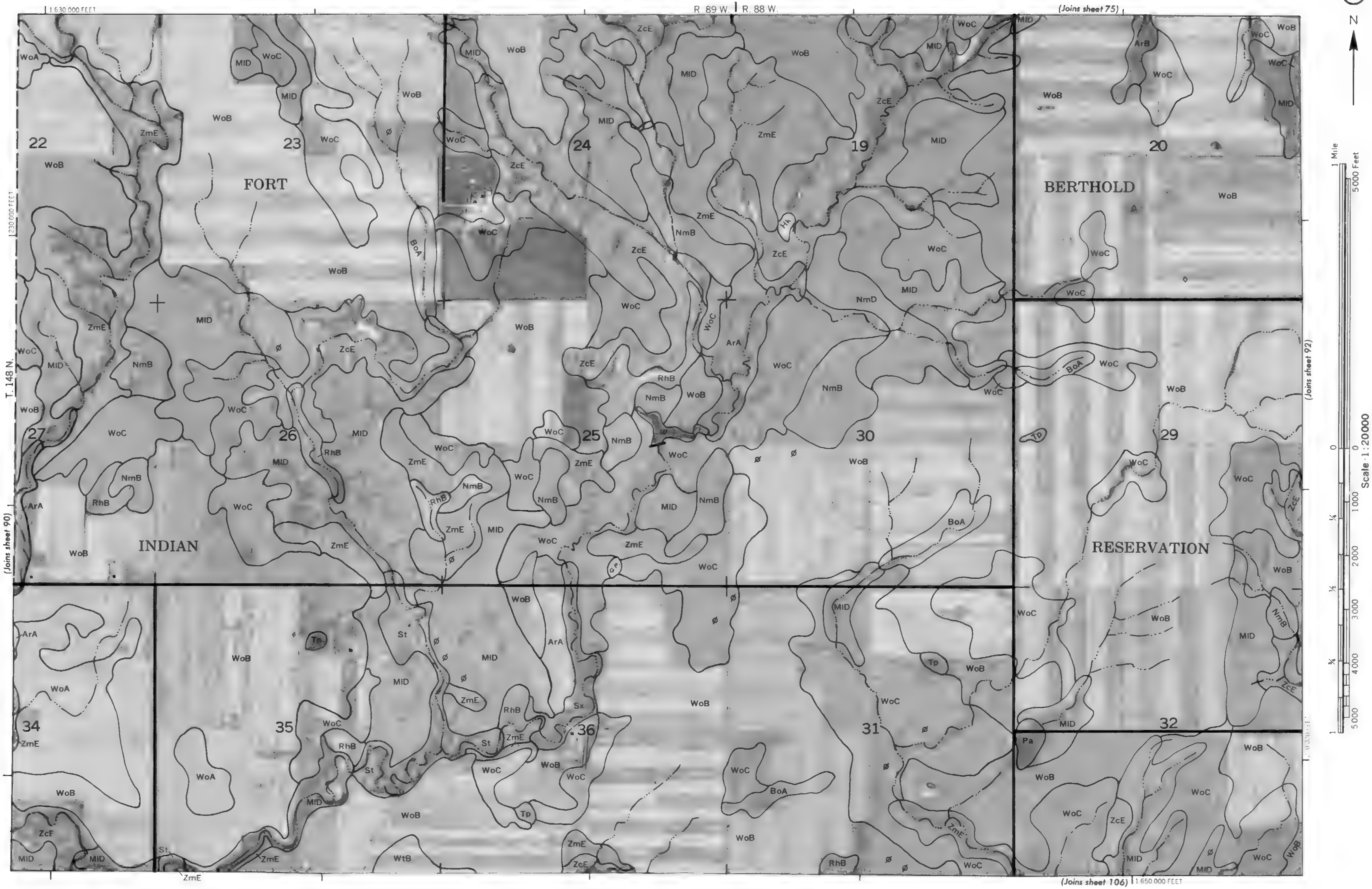

86
N
(Joins sheet 68)
R. 81 W.
R. 80 W.
(Joins sheet 85)
(Joins sheet 87)
(Joins sheet 102)
T. 148 N.
1 Mile
5000 Feet
Scale 1:20000
Crooked Lake
water
1
3
4
5
6
7
8
9
10
12
13
15
16
17
18

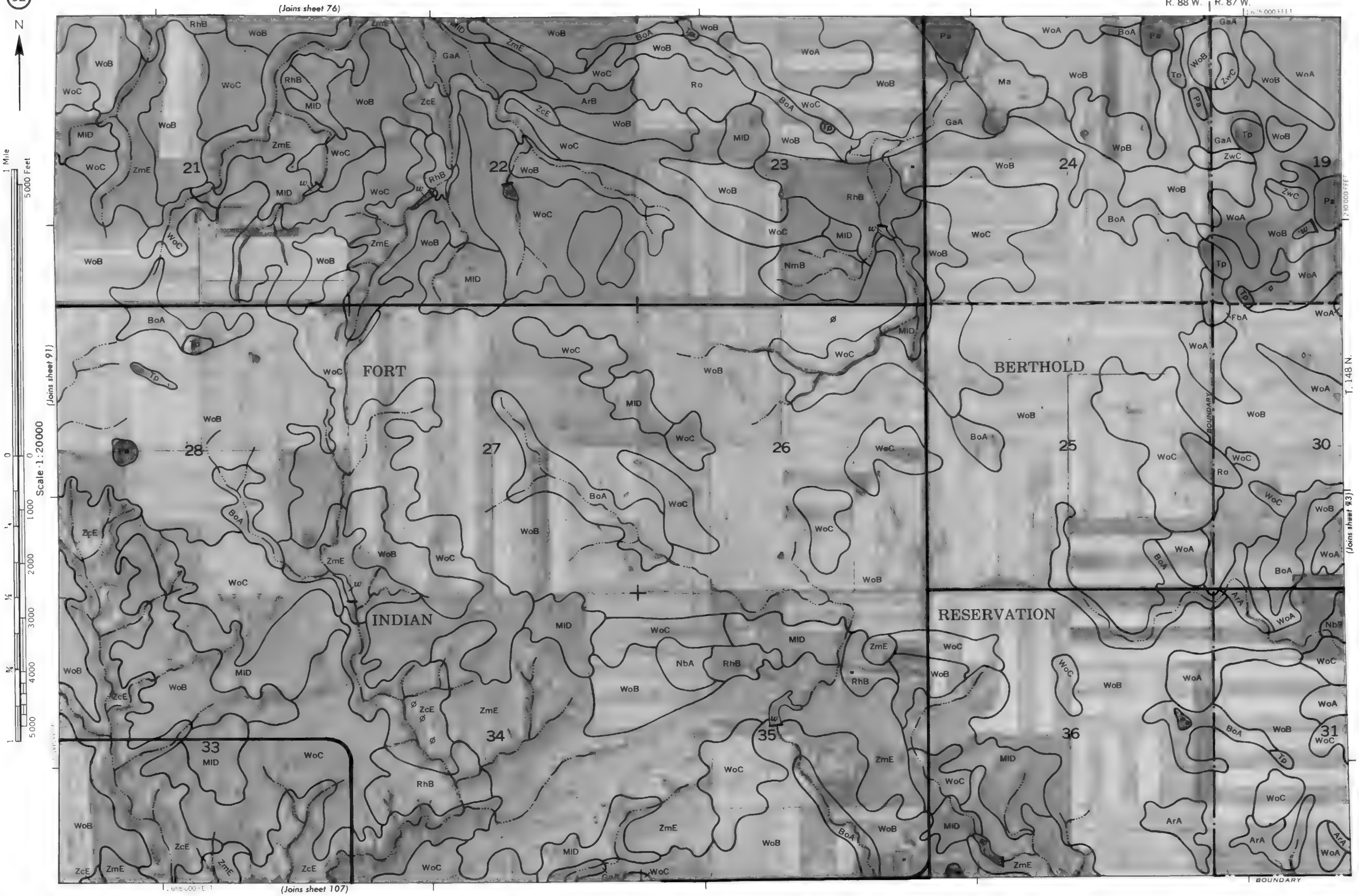

R. 80 W.
R. 79 W.
(Joins sheet 69)
(Joins sheet 86)
(Joins sheet 88)
(Joins sheet 103)
T. 148 N.
1 915 000 FEET
245 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
1000
2000
3000
4000
5000

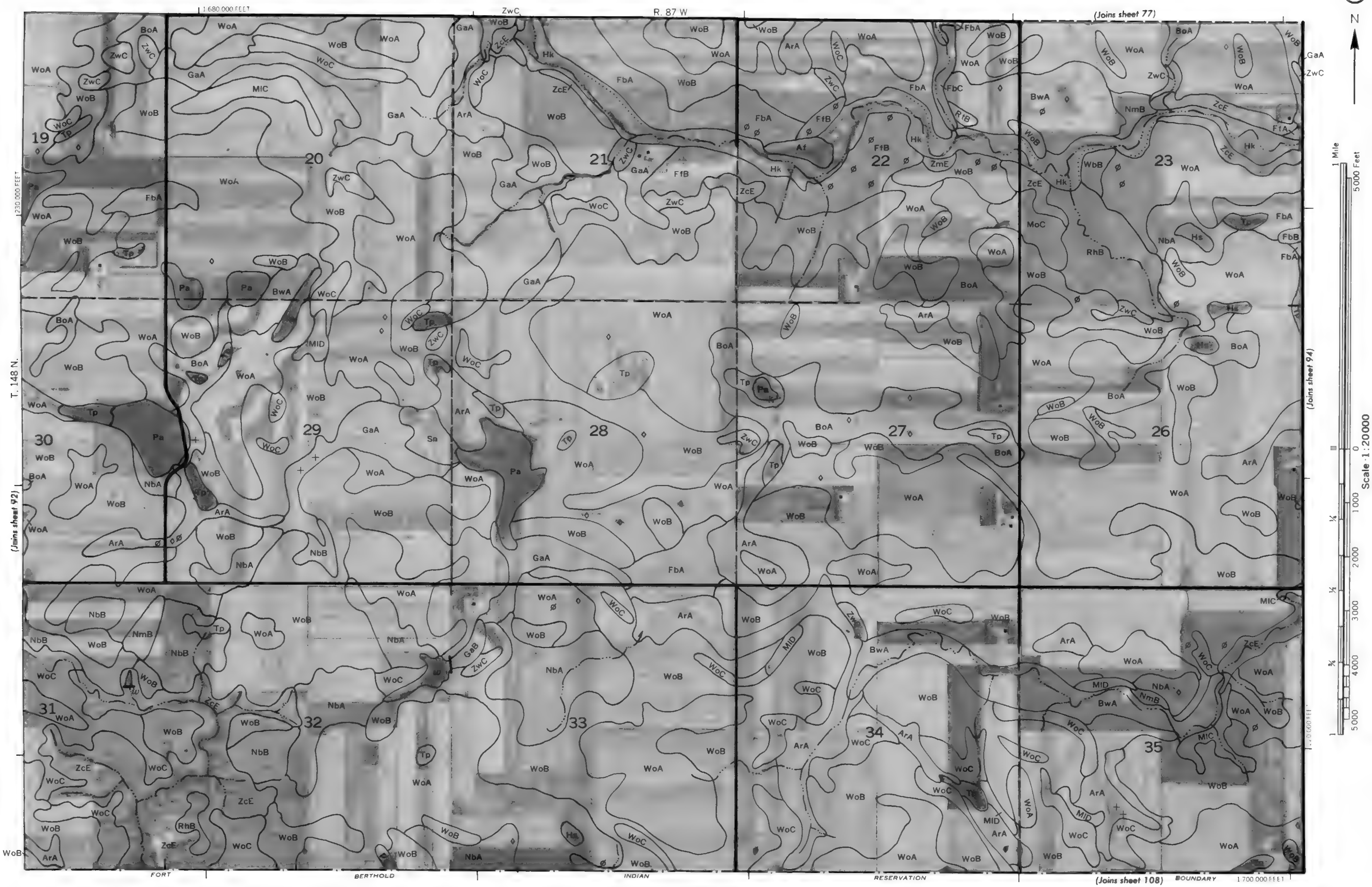

88
N
(Joins sheet 70)
R 79 W
1 960 000 FEET
(Joins sheet 87)
(Joins sheet 104)
T. 148 N.
SHERIDAN COUNTY
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
1
2
3
4
9
10
11
12
13
14
15
16
water


R. 90 W.
(Joins sheet 73)
N
T. 148 N.
(Joins sheet 89)
(Joins sheet 90)
FORT
BERTHOLD
INDIAN
RESERVATION
19
20
21
22
23
26
ChE
WwC
ChD
WwC
RhB
RhB
CaE
WtB
CaE
MlD
ZmE
WwC
NmD
ZmE
WtB
ZmE
ZmE
ZmE
PhC
Sx
ArA
ChD
ChE
PhB
RhB
VwC
WoB
WoC
WoC
WoC
WoC
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
(Joins sheet 72)
R. 89 W.
R. 90 W.
T. 148 N.
FORT
BERTHOLD
INDIAN
RESERVATION
24
19
MlD
ChE
MlD
ZmE
WwC
MdB
WwC
MlD
ChE
CaE
WwC
WtB
CaE
CaE
(Joins upper left)


(Joins sheet 74)
R. 90 W. | R. 89 W.
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
(Joins sheet 89)
(Joins sheet 91)
(Joins sheet 105)
T. 148 N.
FORT
BERTHOLD
INDIAN
RESERVATION
LAKE
SAKAKAWEA
19
20
21
22
24
25
27
28
29
30
31
32
33
34
WoB
WoA
WoC
ArA
Af
Tp
FaA
MIC
MID
Ro
NbB
ChE
ChD
CaE
VwC
Rgc
CbF
ZmE
FbA
FbB
ZcE
w


91
N
(Joins sheet 75)
R. 89 W. | R. 88 W.
1 630 000 FEET
230 000 FEET
T. 148 N.
(Joins sheet 90)
(Joins sheet 92)
(Joins sheet 106)
1 650 000 FEET
FORT
BERTHOLD
INDIAN
RESERVATION
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
Scale 1:20000
1 Mile
5000 Feet
WoA
WoB
WoC
MID
ZmE
ZcE
ZcF
NmB
NmD
RhB
ArA
ArB
BoA
Hk
Tp
St
Sx
Pa
WtB


N
(Joins sheet 76)
(Joins sheet 91)
(Joins sheet 93)
(Joins sheet 107)
R. 88 W.
R. 87 W.
T. 148 N.
Scale 1:20000
1 Mile
5000 Feet
FORT
BERTHOLD
INDIAN
RESERVATION
BOUNDARY
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31

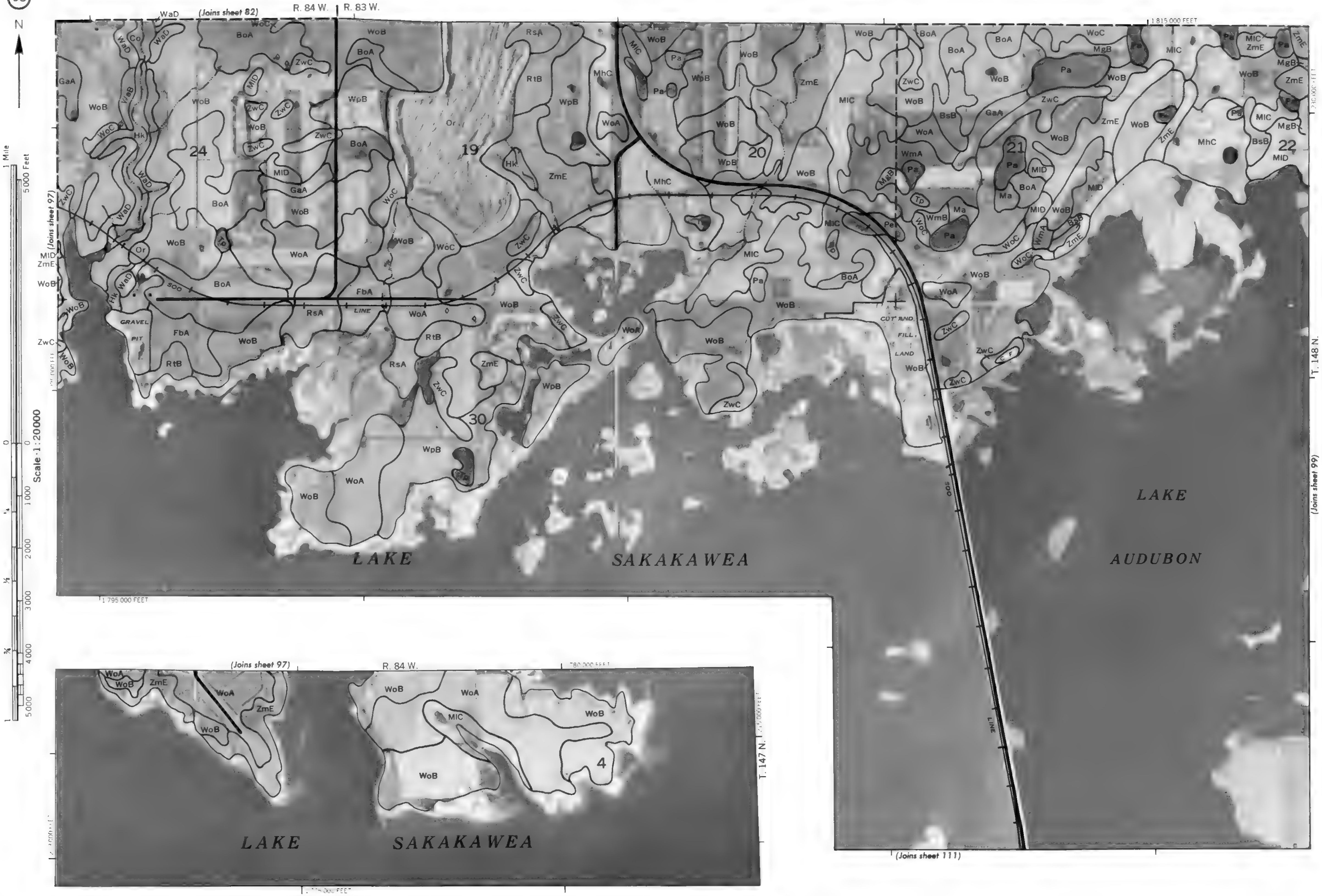

93
N
R. 87 W
T. 148 N.
(Joins sheet 77)
(Joins sheet 94)
(Joins sheet 108)
(Joins sheet 92)
1 680 000 FEET
230 000 FEET
1 700 000 FEET
FORT BERTHOLD INDIAN RESERVATION BOUNDARY
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35
1 Mile
5000 Feet
Scale 1:20000

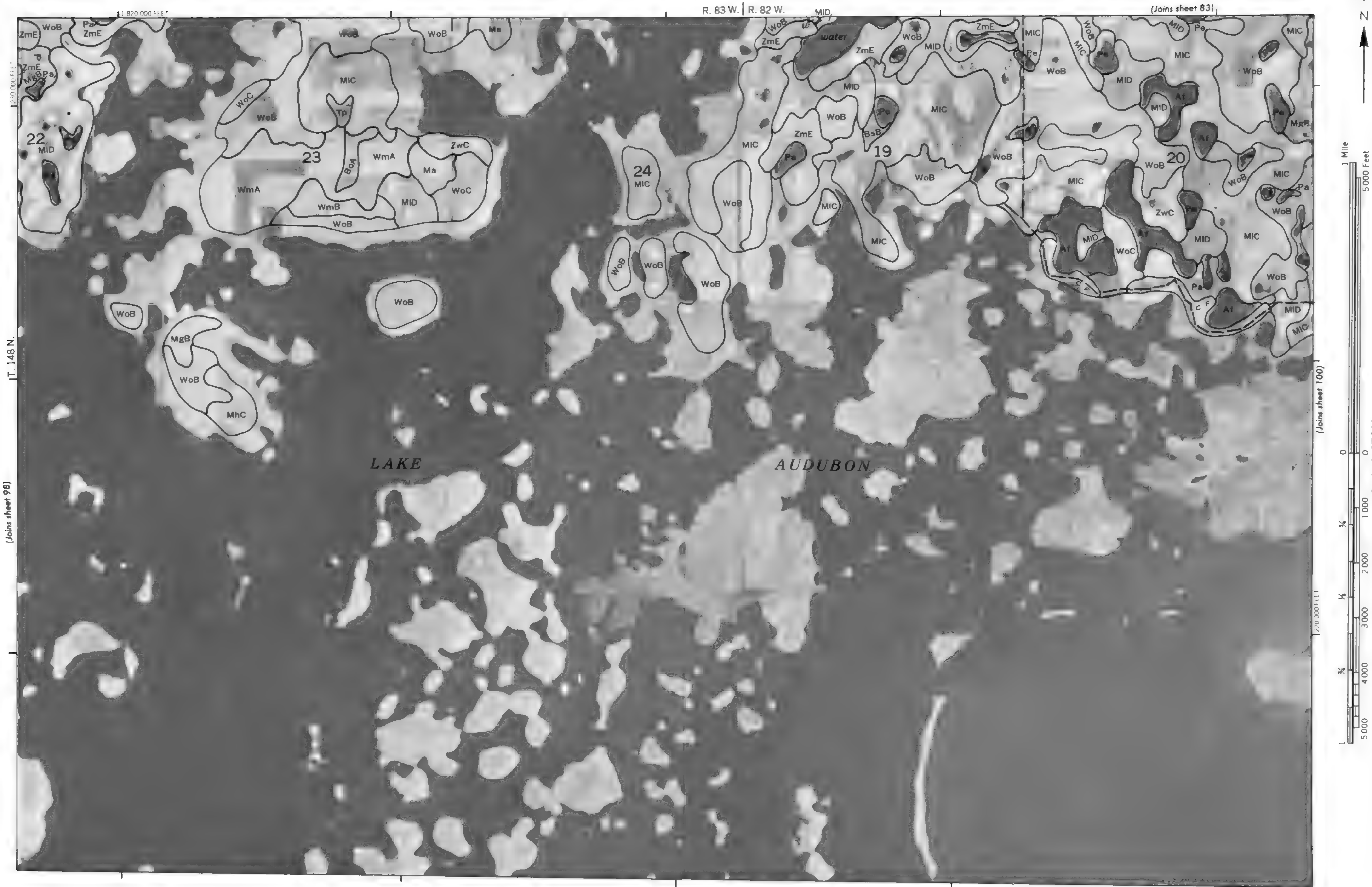

N
(Joins sheet 78)
R. 87 W.
R. 86 W.
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 93)
(Joins sheet 95)
(Joins sheet 109)
T. 148 N.
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36
LAKE SAKAKAWEA
water
FORT BERTHOLD INDIAN RESERVATION BOUNDARY


95
N
(Joins sheet 79)
R. 86 W. | R. 85 W.
T. 148 N.
(Joins sheet 94)
(Joins sheet 96)
(Joins sheet 110)
LAKE
SAKAKAWEA
water
22
23
24
19
20
27
26
25
30
29
34
36
31
32
1 Mile
5000 Feet
Scale 1:20000
1 745 000 FEET

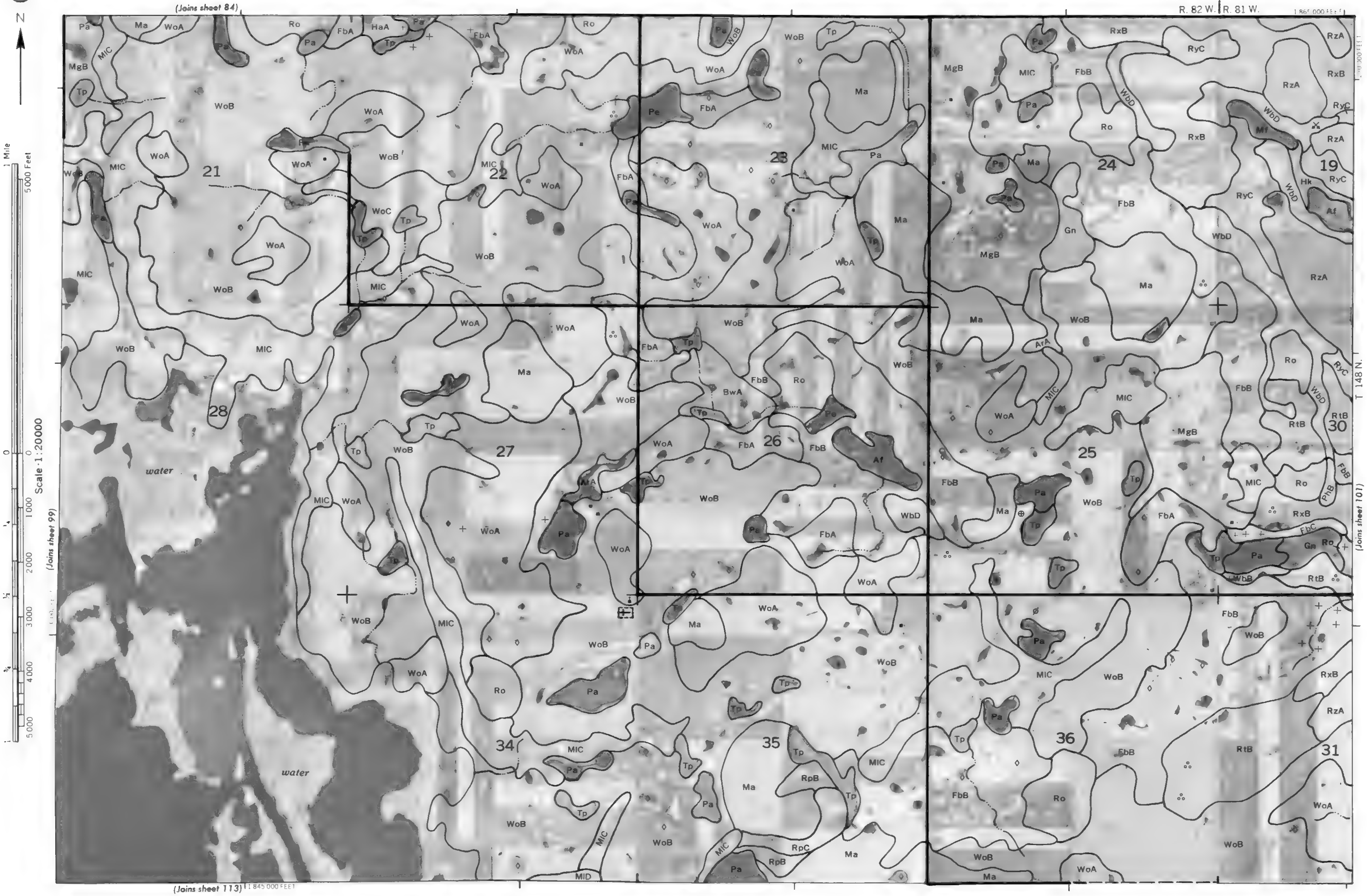

N
(Joins sheet 80)
R. 85 W. | R. 84 W.
1 770 000 FEET
(Joins sheet 95)
(Joins sheet 97)
T. 148 N.
Scale 1:20000
1 Mile
5000 Feet
0
¼
½
¾
1
1000
2000
3000
4000
5000
220 000 FEET
760 000 FEET
21
22
23
24
19
28
27
26
25
30
33
34
35
36
water
LAKE
SAKAKAWEA

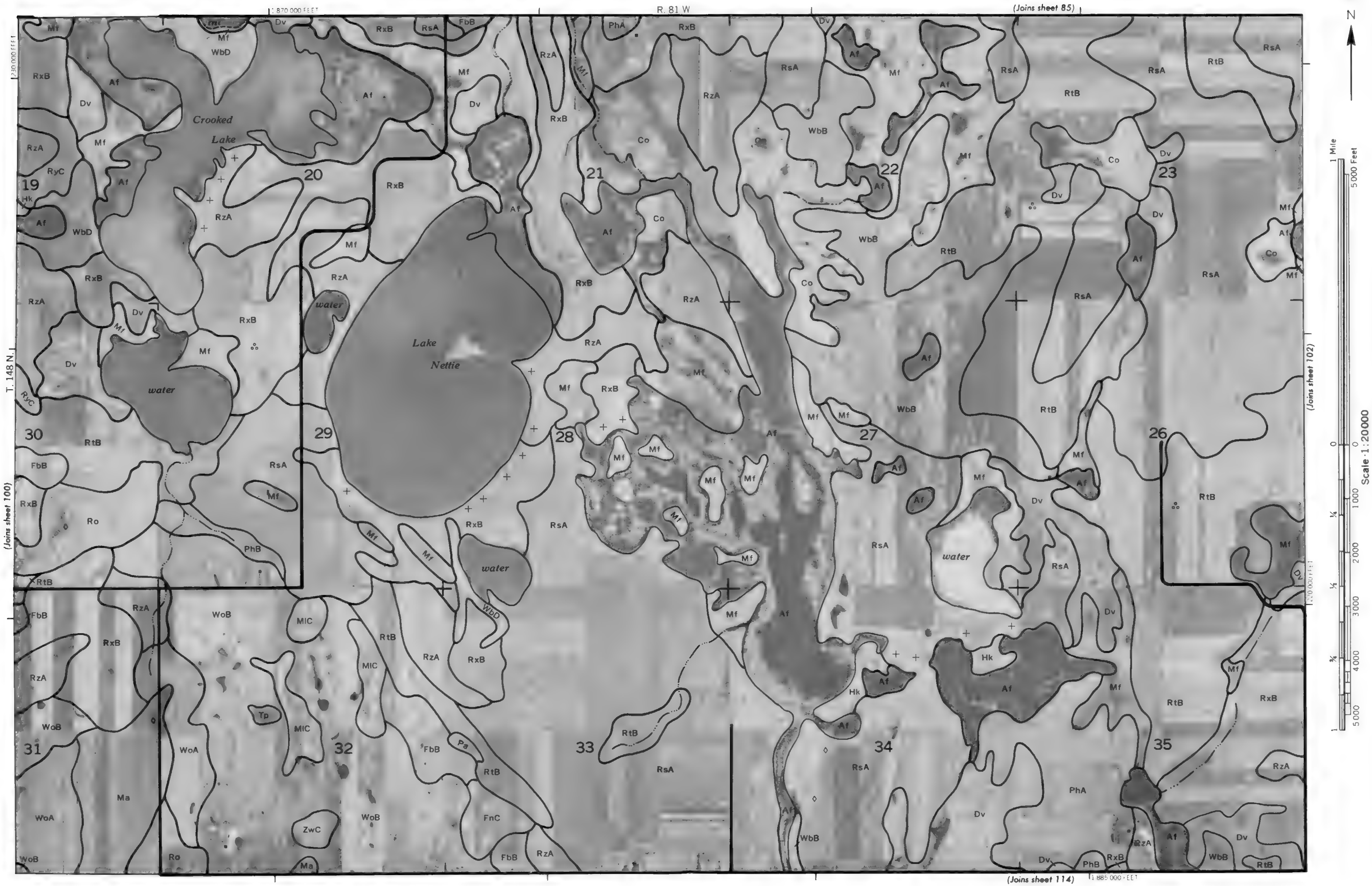
1 775 000 FEET
R. 84 W.
(Joins sheet 81)
230 000 FEET
(Joins sheet 96)
T. 148 N.
(Joins sheet 98)
220 000 FEET
(Joins inset, sheet 98)
1 790 000 FEET
N
1 Mile
5000 Feet
0
0
Scale 1:20000
1000
2000
3000
4000
5000
19
20
21
22
23
27
28
29
30
31
32
33
34
SOO LINE
GRAVEL PIT
water
LAKE SAKAKAWEA
WoA
WoB
WoC
ZwC
ZmE
MID
Tp
Pa
BoA
BsB
GaA
WpB
WbD
ByB
BwA
FbA
FbB
ArA
Ma
RtB
RhB
WmA
WmB
WaD
WaB
RsA
ZpE
Sn

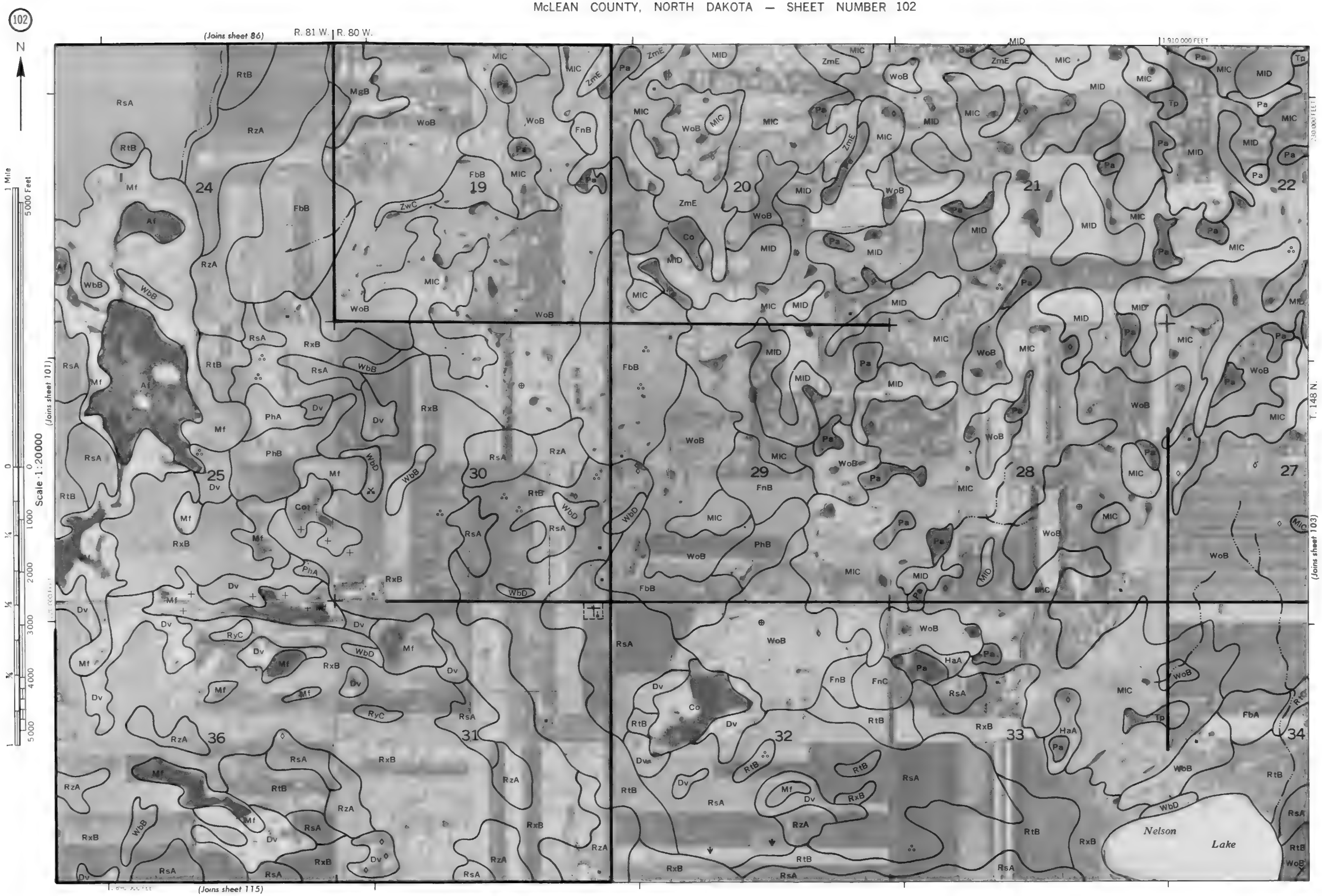

N
(Joins sheet 82)
R. 84 W.
R. 83 W.
(Joins sheet 97)
(Joins sheet 99)
(Joins sheet 111)
T. 148 N.
T. 147 N.
1 815 000 FEET
1 795 000 FEET
1 Mile
5 000 Feet
Scale 1:20000
24
19
20
21
22
30
4
GRAVEL PIT
CUT AND FILL LAND
SOO LINE
LAKE SAKAKAWEA
LAKE AUDUBON

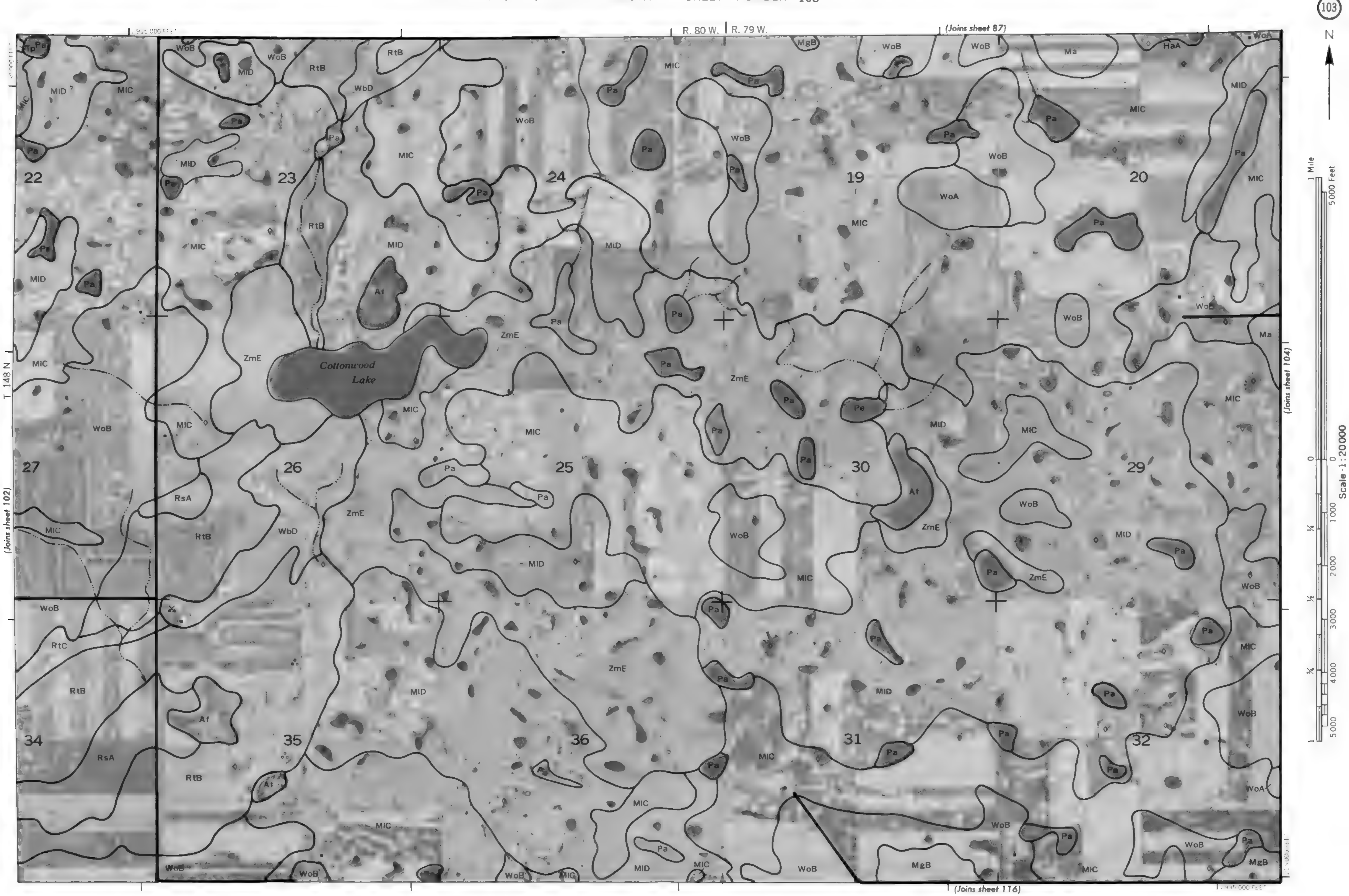

R. 83 W.
R. 82 W.
(Joins sheet 83)
(Joins sheet 98)
(Joins sheet 100)
(Joins sheet 112)
T. 148 N.
LAKE
AUDUBON
water
22
23
24
19
20
N
Scale 1:20000
1 Mile
5000 Feet

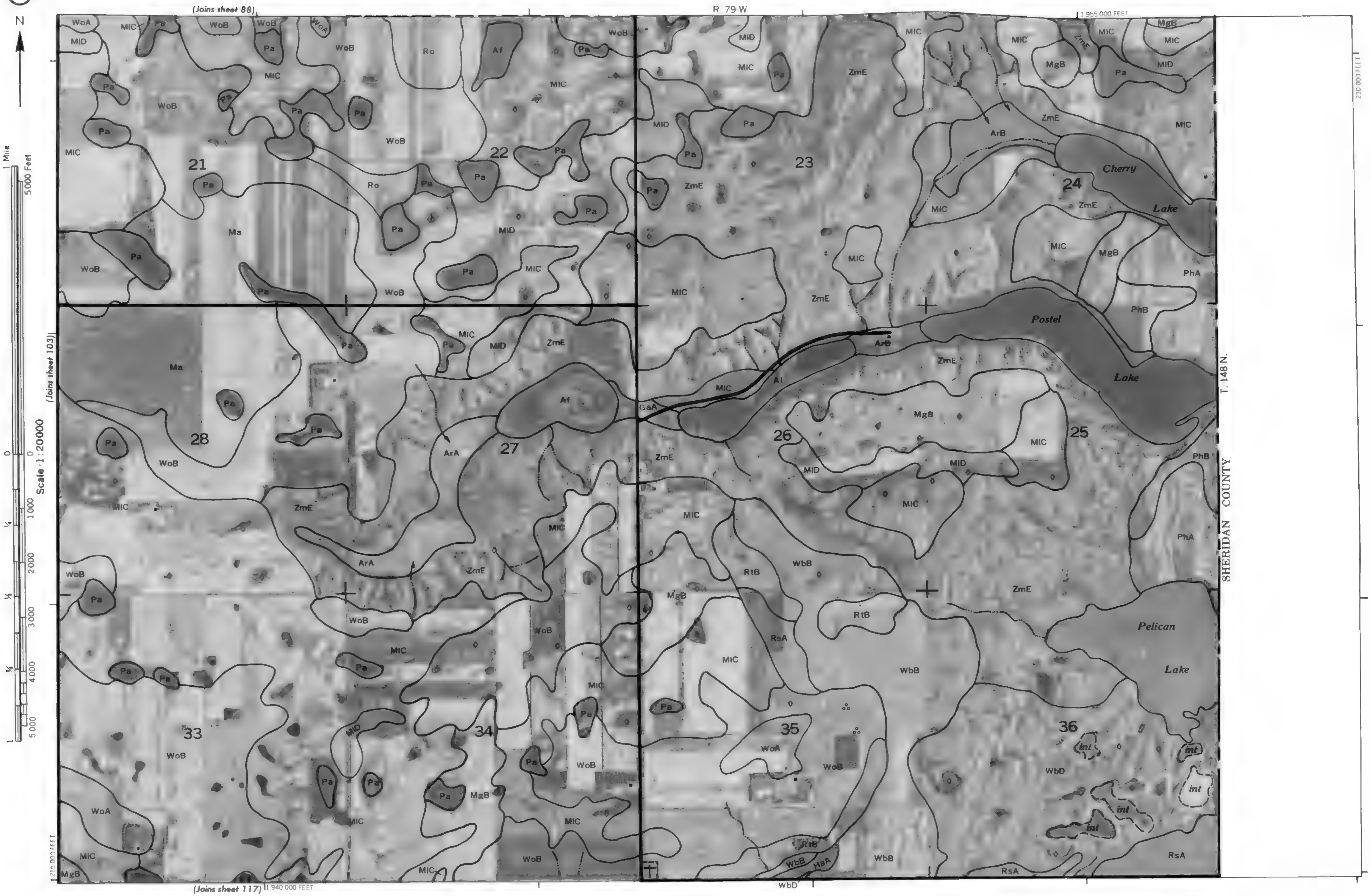
McLEAN COUNTY, NORTH DAKOTA — SHEET NUMBER 100

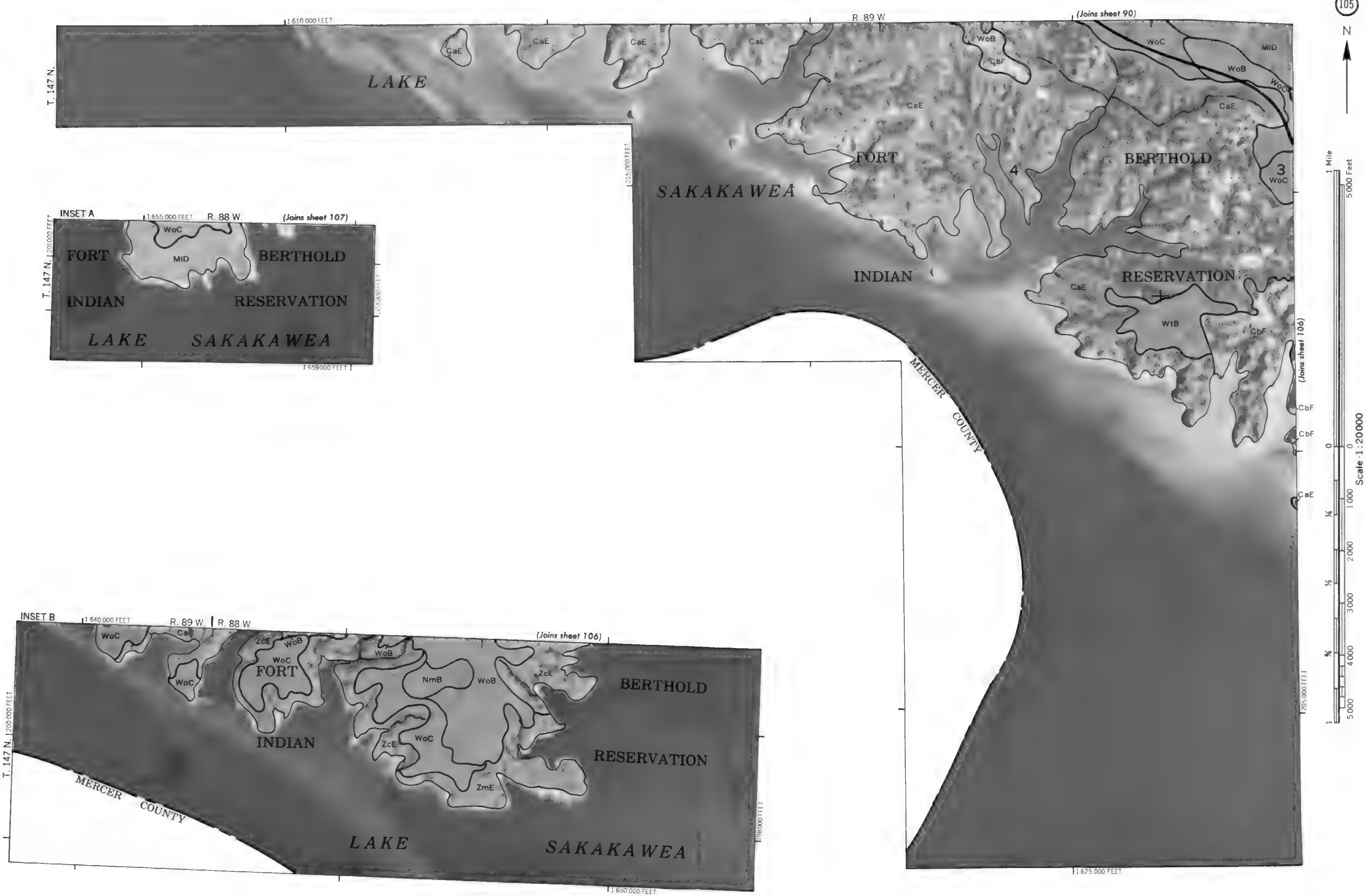


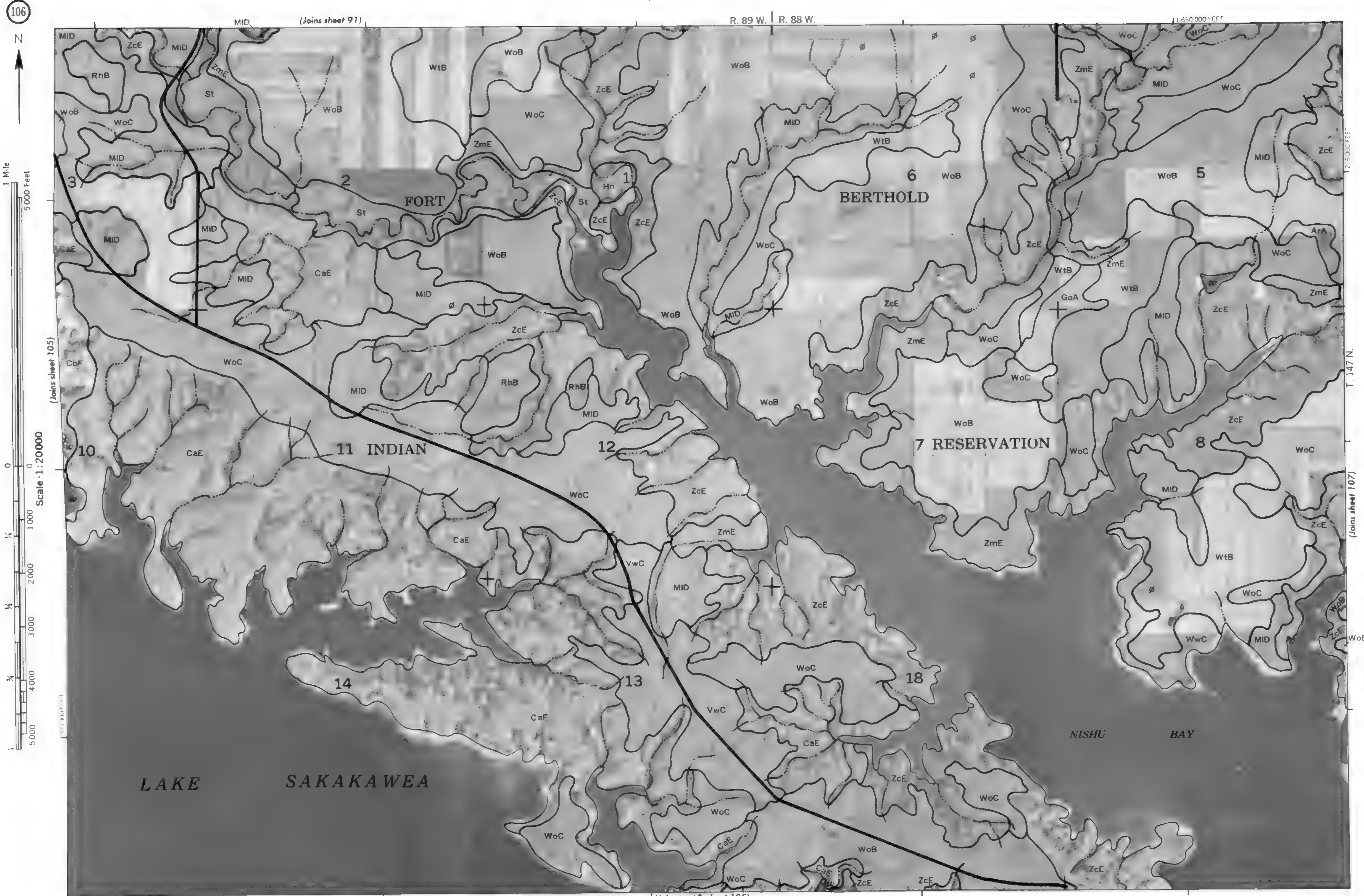

101
N
R. 81 W
(Joins sheet 85)
(Joins sheet 100)
(Joins sheet 102)
(Joins sheet 114)
T. 148 N.
1 870 000 FEET
1 885 000 FEET
Crooked Lake
Lake Nettie
water
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
Scale 1:20000
1 Mile
5000 Feet

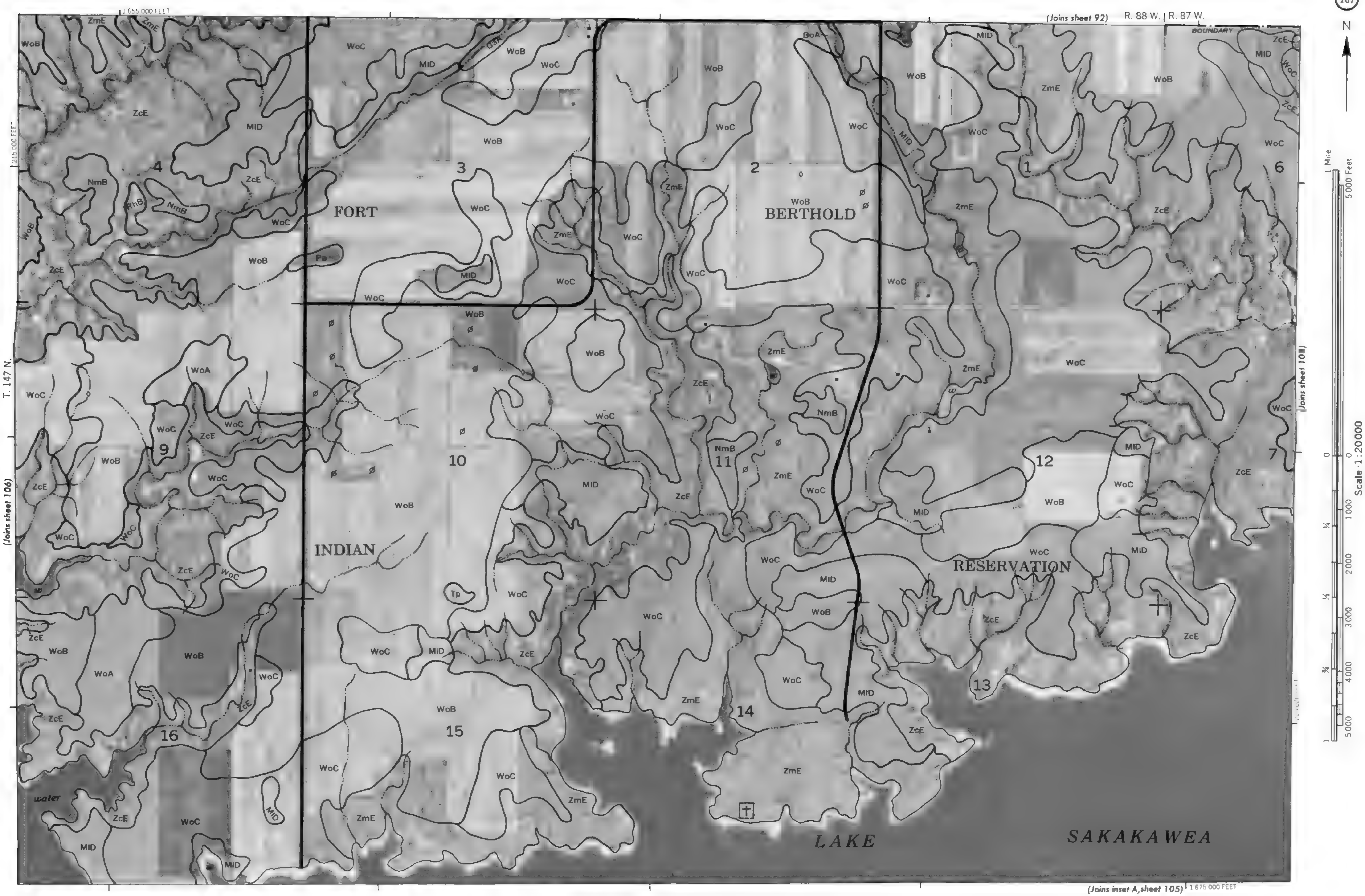

102
N
(Joins sheet 86)
R. 81 W.
R. 80 W.
(Joins sheet 101)
(Joins sheet 103)
(Joins sheet 115)
T. 148 N.
Scale 1:20000
1 Mile
5000 Feet
Nelson
Lake

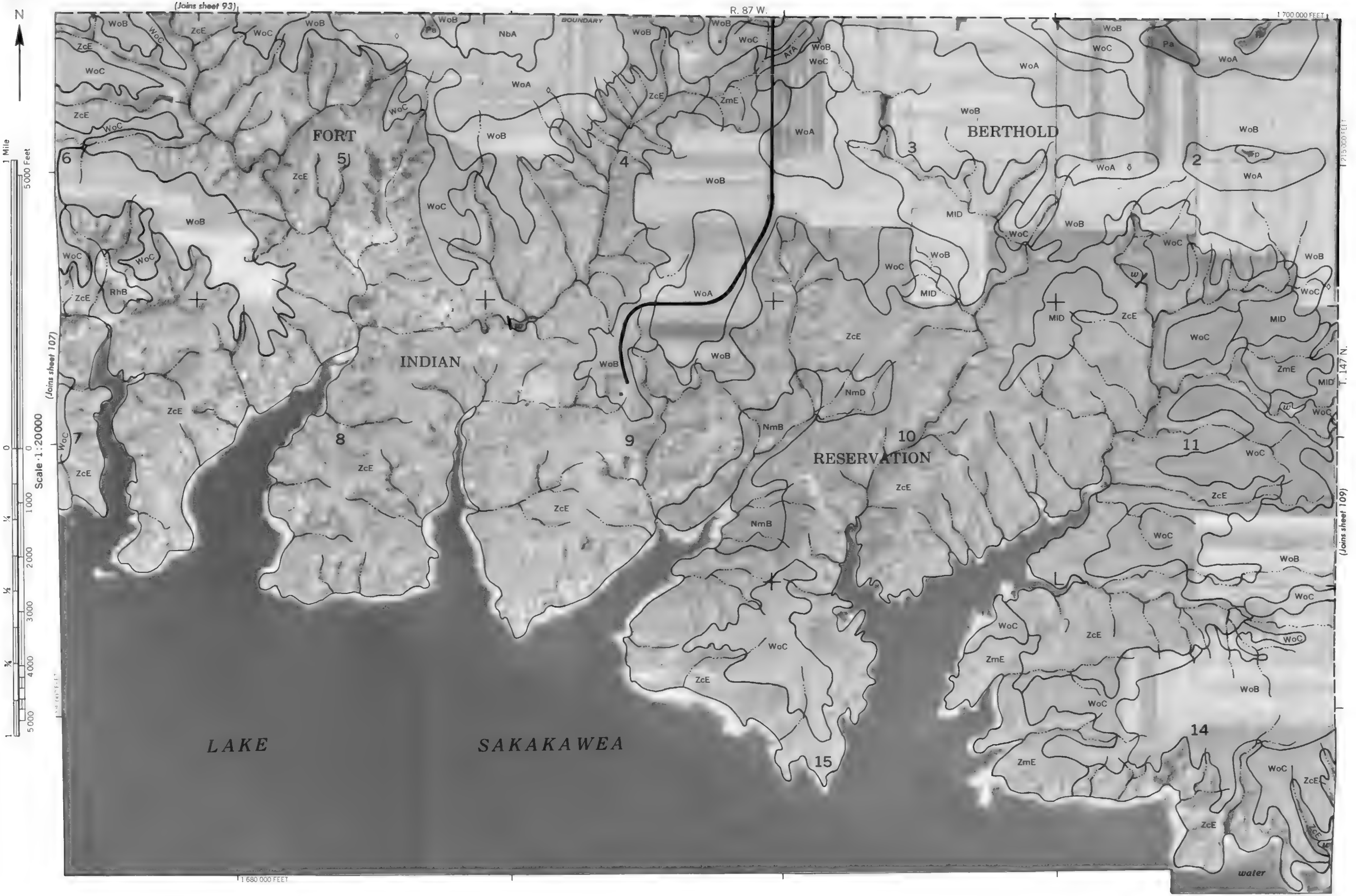

103
N
R. 80 W.
R. 79 W.
(Joins sheet 87)
(Joins sheet 104)
(Joins sheet 116)
(Joins sheet 102)
T 148 N
Cottonwood Lake
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
WoB
WoA
MID
MIC
Pa
Pe
Tp
RtB
RtC
RsA
WbD
ZmE
Af
MgB
HaA
Ma

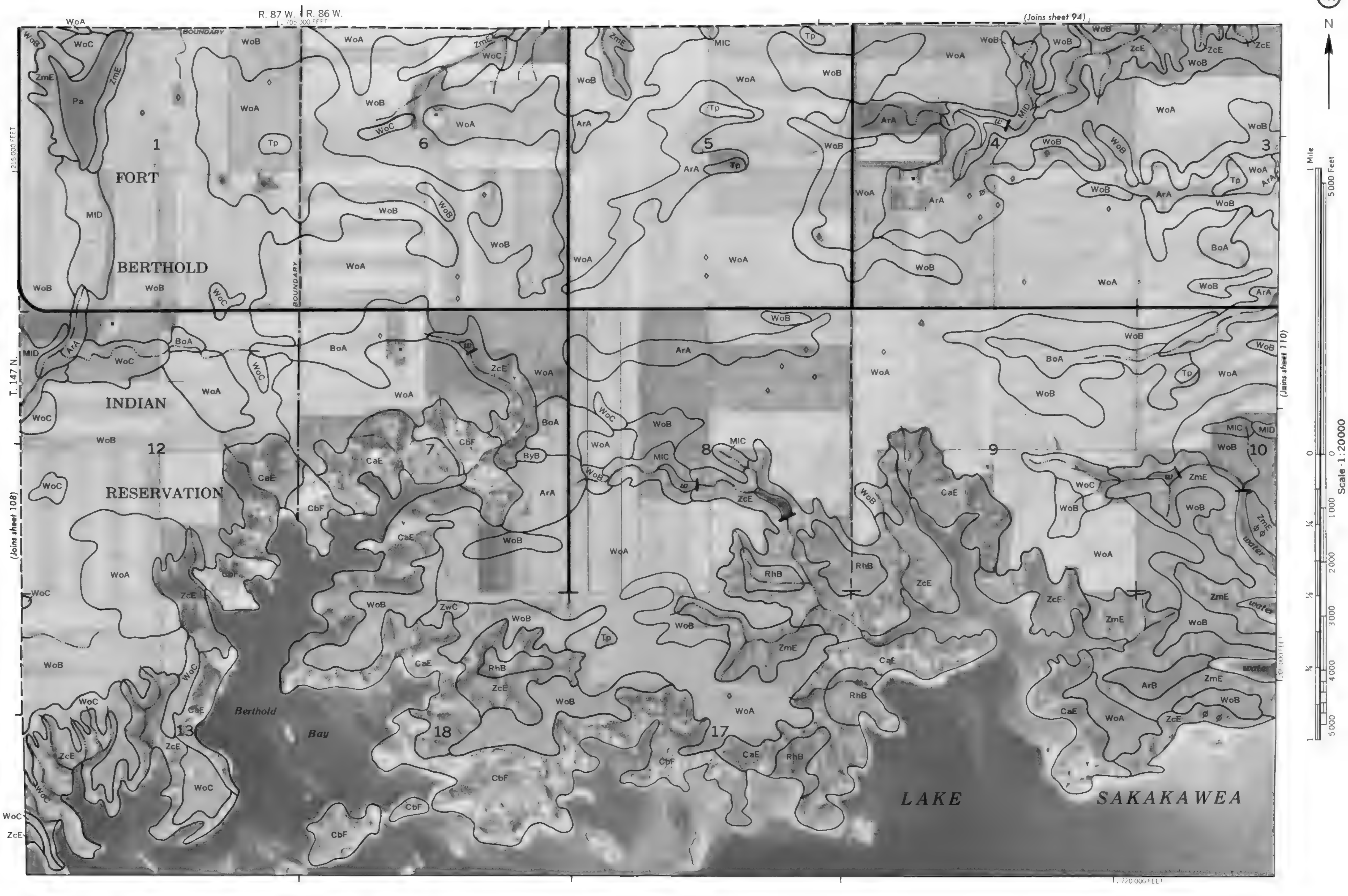

104
N
(Joins sheet 88)
R 79 W
1 955 000 FEET
230 000 FEET
(Joins sheet 103)
T. 148 N.
SHERIDAN COUNTY
(Joins sheet 117)
1 940 000 FEET
215 000 FEET
Scale 1:20000
1 Mile
5000 Feet
Cherry Lake
Postel Lake
Pelican Lake
21
22
23
24
25
26
27
28
33
34
35
36


105
N
(Joins sheet 90)
R. 89 W.
1 610 000 FEET
T. 147 N.
LAKE
SAKAKAWEA
FORT
BERTHOLD
INDIAN
RESERVATION
MERCER
COUNTY
CaE
WoB
CbF
WoC
MID
WtB
4
3
(Joins sheet 106)
1 625 000 FEET
205 000 FEET
INSET A
1 655 000 FEET
R. 88 W.
(Joins sheet 107)
1 659 000 FEET
INSET B
1 640 000 FEET
R. 89 W.
R. 88 W.
(Joins sheet 106)
ZcE
NmB
ZmE
1 650 000 FEET
1 Mile
5000 Feet
Scale 1:20000

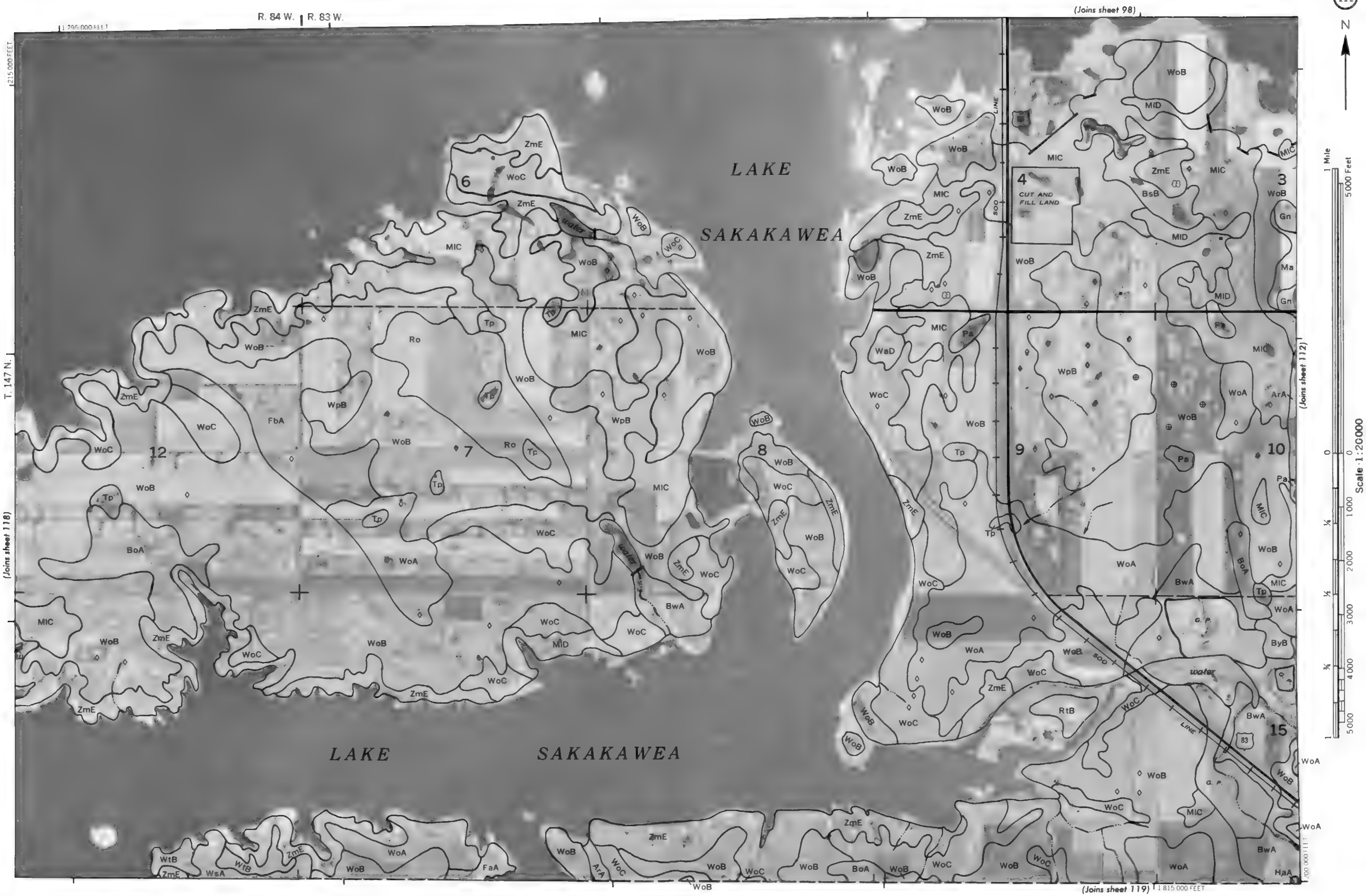

106
N
(Joins sheet 91)
R. 89 W.
R. 88 W.
1 650 000 FEET
215 000 FEET
T. 147 N.
(Joins sheet 105)
(Joins sheet 107)
(Joins inset 8, sheet 105)
1 Mile
5000 Feet
Scale 1:20000
FORT
BERTHOLD
INDIAN
RESERVATION
LAKE
SAKAKAWEA
NISHU
BAY
MID
ZcE
RhB
St
ZmE
WtB
WoB
WoC
CaE
CbF
Hn
GoA
ArA
VwC
WwC
1
2
3
5
6
7
8
10
11
12
13
14
18


107
N
(Joins sheet 92)
R. 88 W. | R. 87 W.
BOUNDARY
T. 147 N.
(Joins sheet 106)
(Joins sheet 108)
(Joins inset A, sheet 105)
1 655 000 FEET
1 675 000 FEET
215 000 FEET
FORT
BERTHOLD
INDIAN
RESERVATION
LAKE
SAKAKAWEA
water
1 Mile
5000 Feet
Scale 1:20000
1
2
3
4
6
7
9
10
11
12
13
14
15
16
WoB
WoC
WoA
ZmE
ZcE
MID
NmB
RhB
GaA
BoA
Pa
Tp

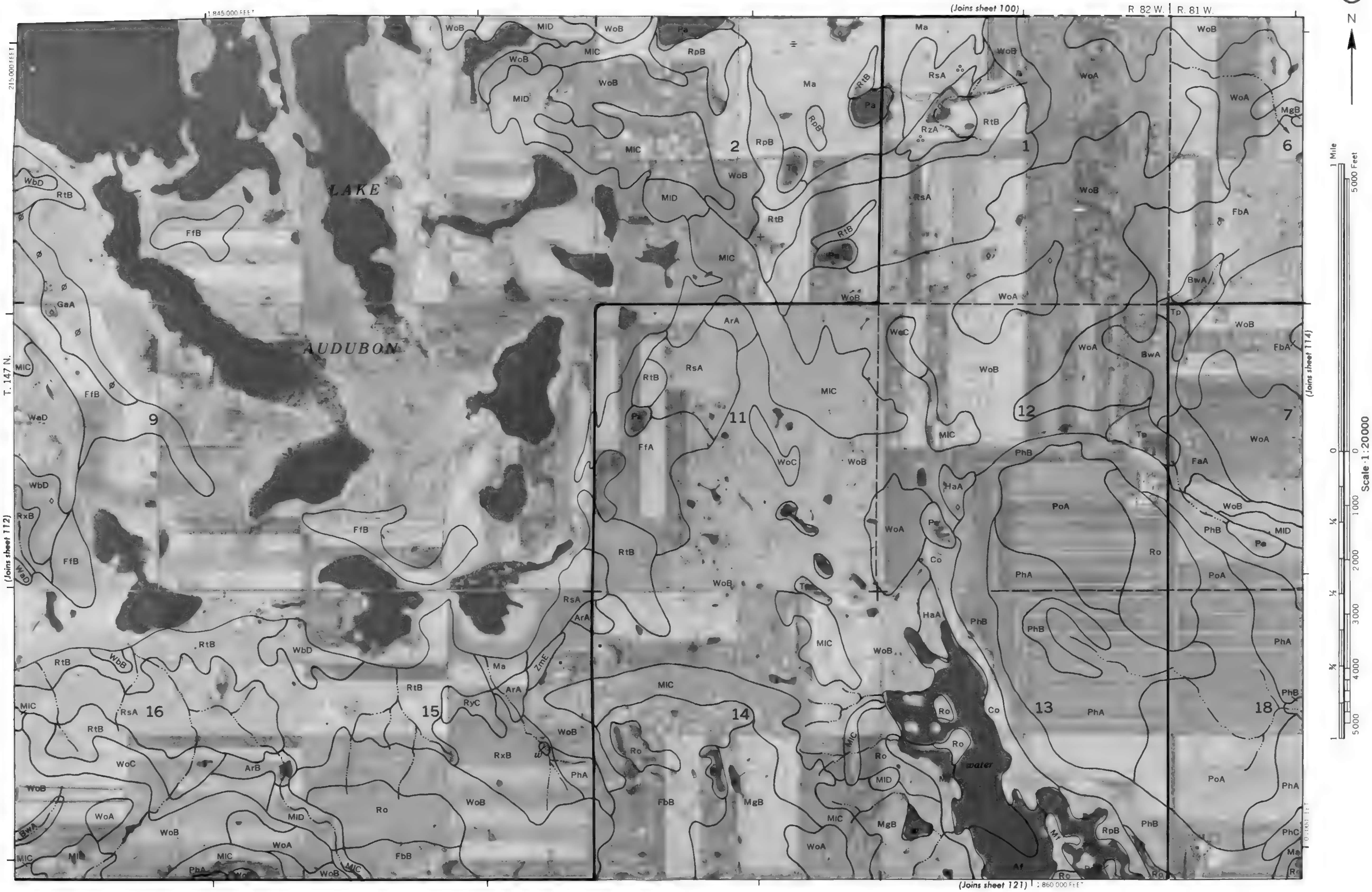

N
(Joins sheet 93)
R. 87 W.
BOUNDARY
1 700 000 FEET
FORT
BERTHOLD
INDIAN
RESERVATION
LAKE
SAKAKAWEA
(Joins sheet 107)
(Joins sheet 109)
T. 147 N.
1 680 000 FEET
water
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
2
3
4
5
6
7
8
9
10
11
14
15
WoA
WoB
WoC
ZcE
ZmE
NbA
Pa
MlD
NmB
NmD
RhB

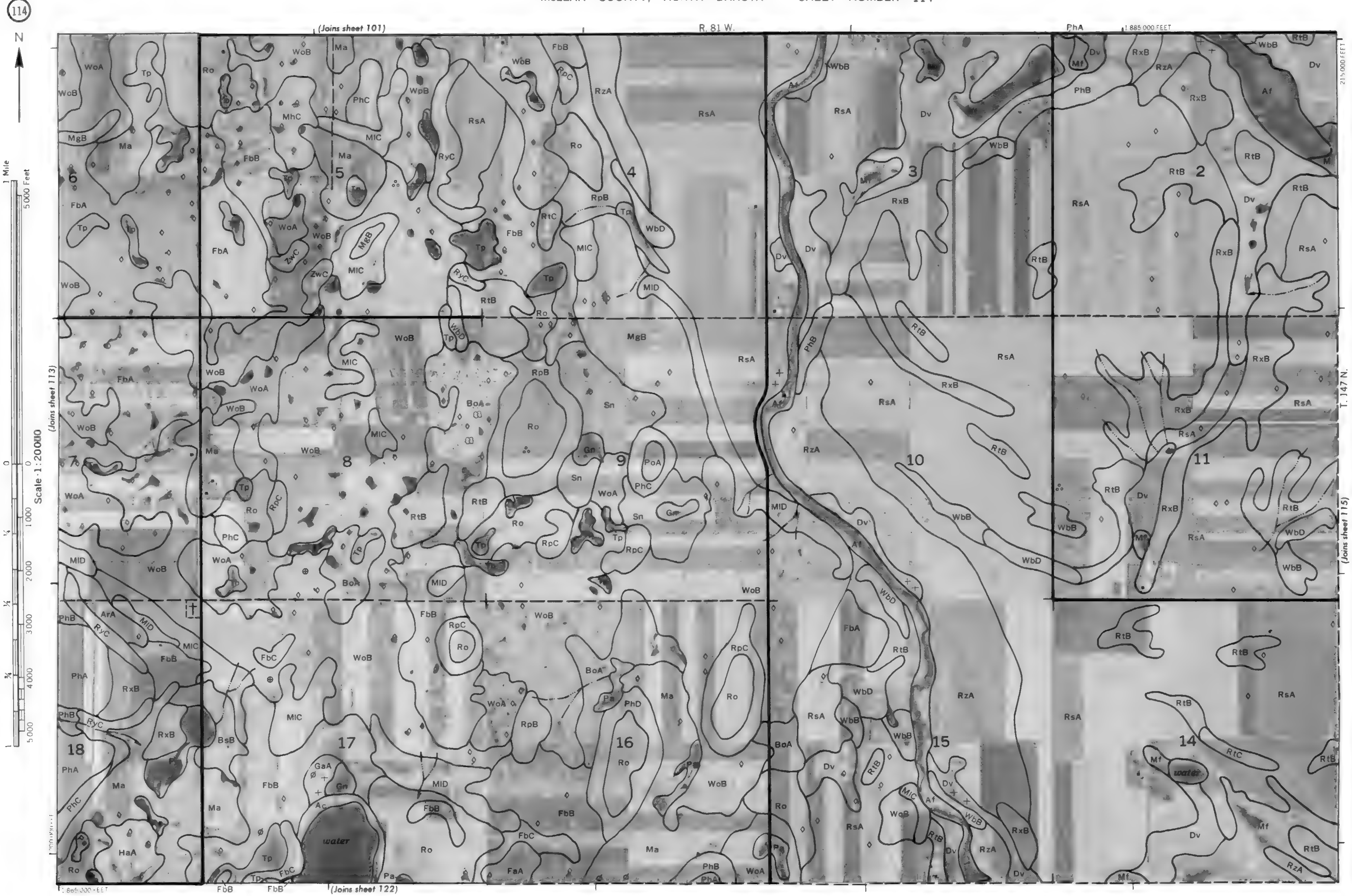

109
N
R. 87 W.
R. 86 W.
(Joins sheet 94)
(Joins sheet 110)
(Joins sheet 108)
T. 147 N.
BOUNDARY
FORT
BERTHOLD
INDIAN
RESERVATION
Berthold
Bay
LAKE
SAKAKAWEA
1
6
5
4
3
12
7
8
9
10
13
18
17
WoA
WoB
WoC
ZmE
ZcE
Pa
MID
MIC
Tp
ArA
ArB
BoA
ByB
CaE
CbF
RhB
ZwC
water
1 Mile
5 000 Feet
Scale 1:20000

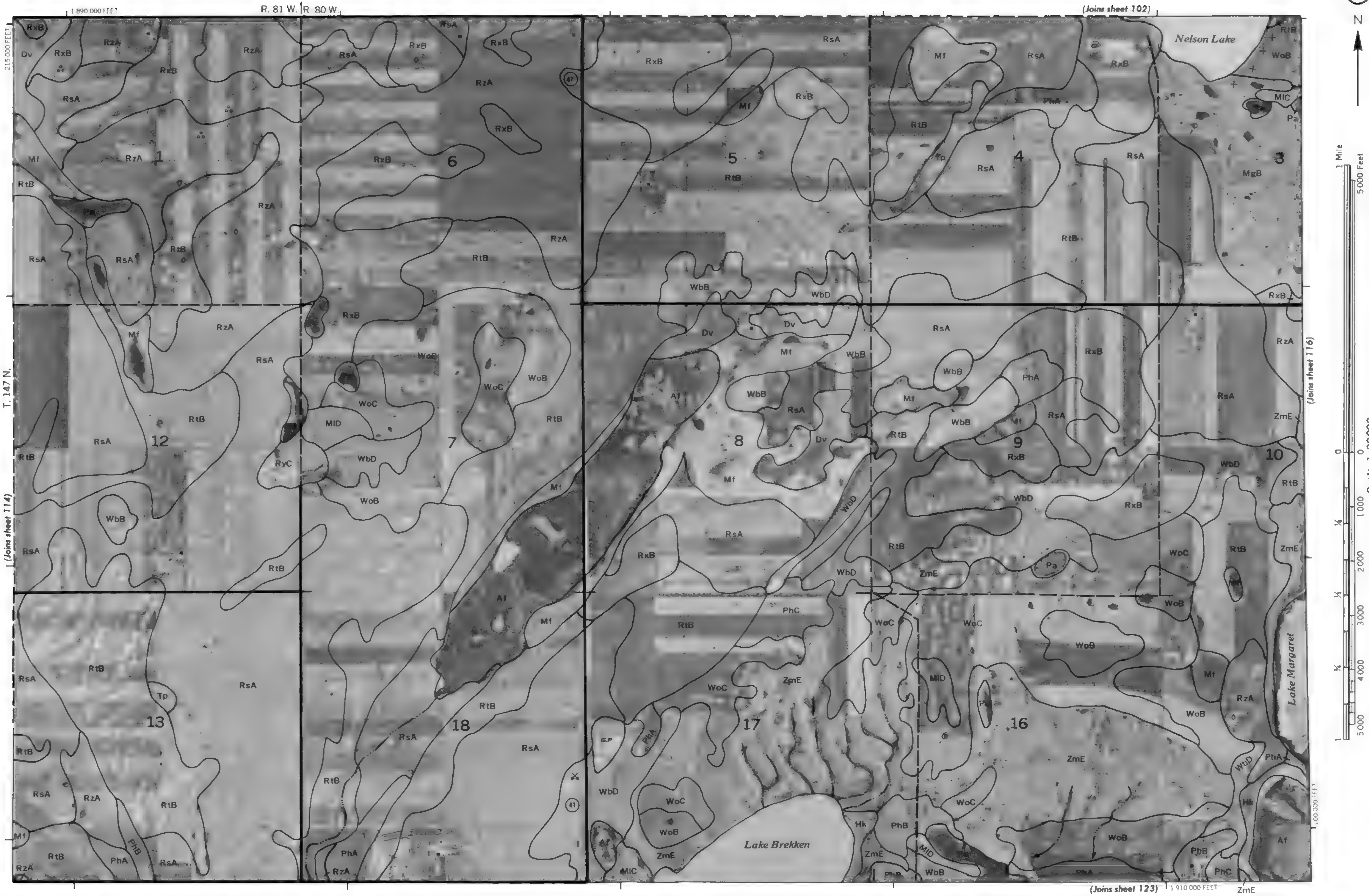

110
N
(Joins sheet 95)
R. 86 W.
R. 85 W.
T. 147 N.
(Joins sheet 107)
1 Mile
5000 Feet
Scale 1:20000
LAKE
SAKAKAWEA
1
2
3
10
11
12
WoA
WoB
WoC
MID
MIC
ArA
FbB
St
ZmE
ZcE
ZcB
ZwC
NmB
Tp

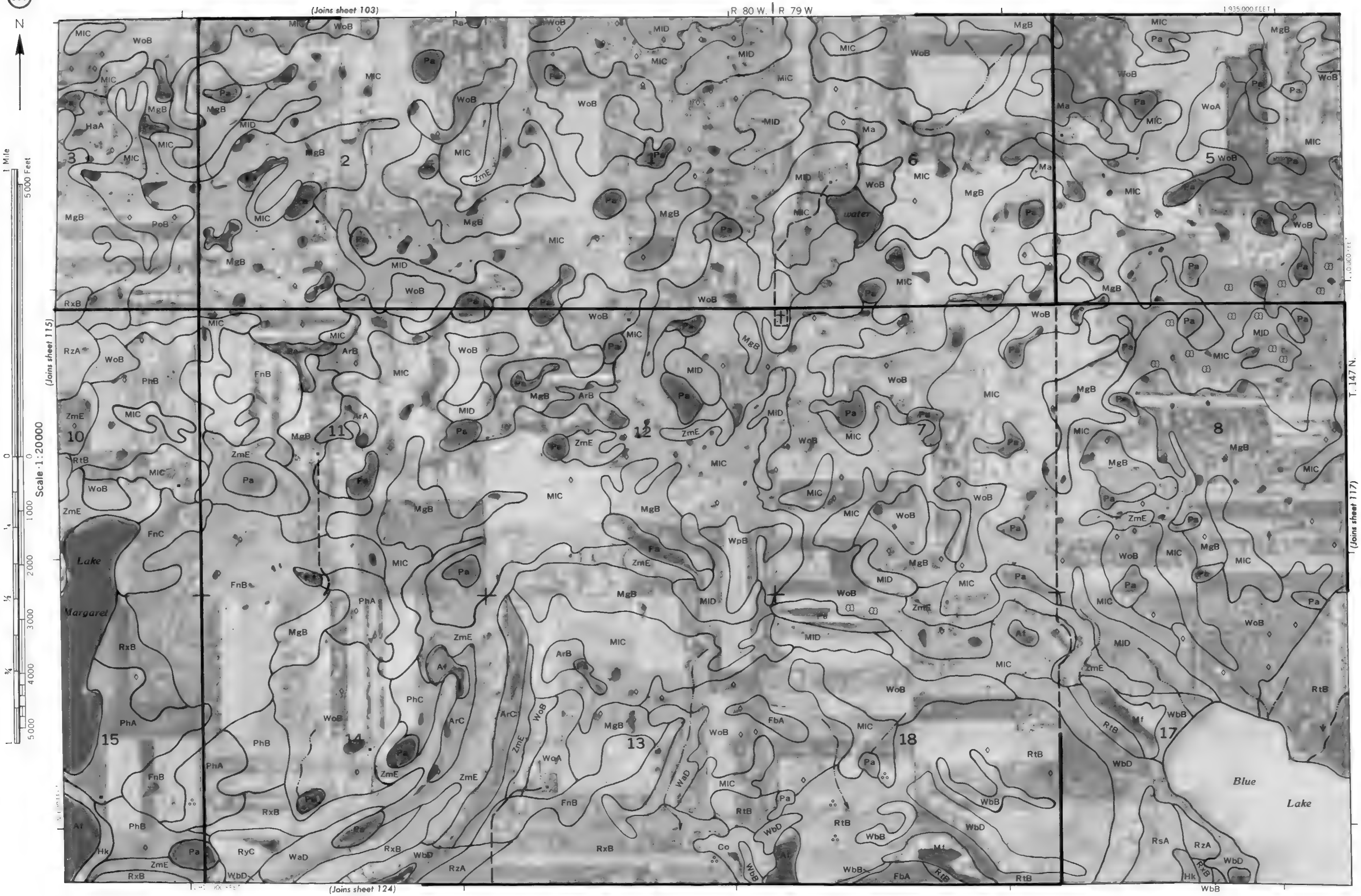

111
(Joins sheet 98)
(Joins sheet 112)
(Joins sheet 118)
(Joins sheet 119)
R. 84 W.
R. 83 W.
T. 147 N.
LAKE SAKAKAWEA
LAKE SAKAKAWEA
CUT AND FILL LAND
SOO LINE
N
Scale 1:20000
1 Mile
5000 Feet

McLEAN COUNTY, NORTH DAKOTA — SHEET NUMBER 112


(Joins sheet 100)
R. 82 W.
R. 81 W.
1 845 000 FEET
215 000 FEET
T. 147 N.
(Joins sheet 112)
(Joins sheet 114)
(Joins sheet 121)
860 000 FEET
LAKE
AUDUBON
N
1 Mile
5000 Feet
Scale 1:20000
1
2
6
7
9
11
12
13
14
15
16
18
water
WoB
MlD
MlC
Pa
RpB
Ma
RtB
RsA
RzA
WoA
MgB
FbA
FfB
WbD
GaA
FfA
ArA
WoC
BwA
Tp
FbA
FaA
PhB
HaA
PoA
Ro
PhA
Co
WaD
WbB
RxB
RyC
ArB
ZmE
FbB
MgB
PhC
Af
Mt
Pe
WeC


114
N
(Joins sheet 101)
R. 81 W.
1 885 000 FEET
215 000 FEET
T. 147 N.
(Joins sheet 113)
(Joins sheet 115)
(Joins sheet 122)
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
water

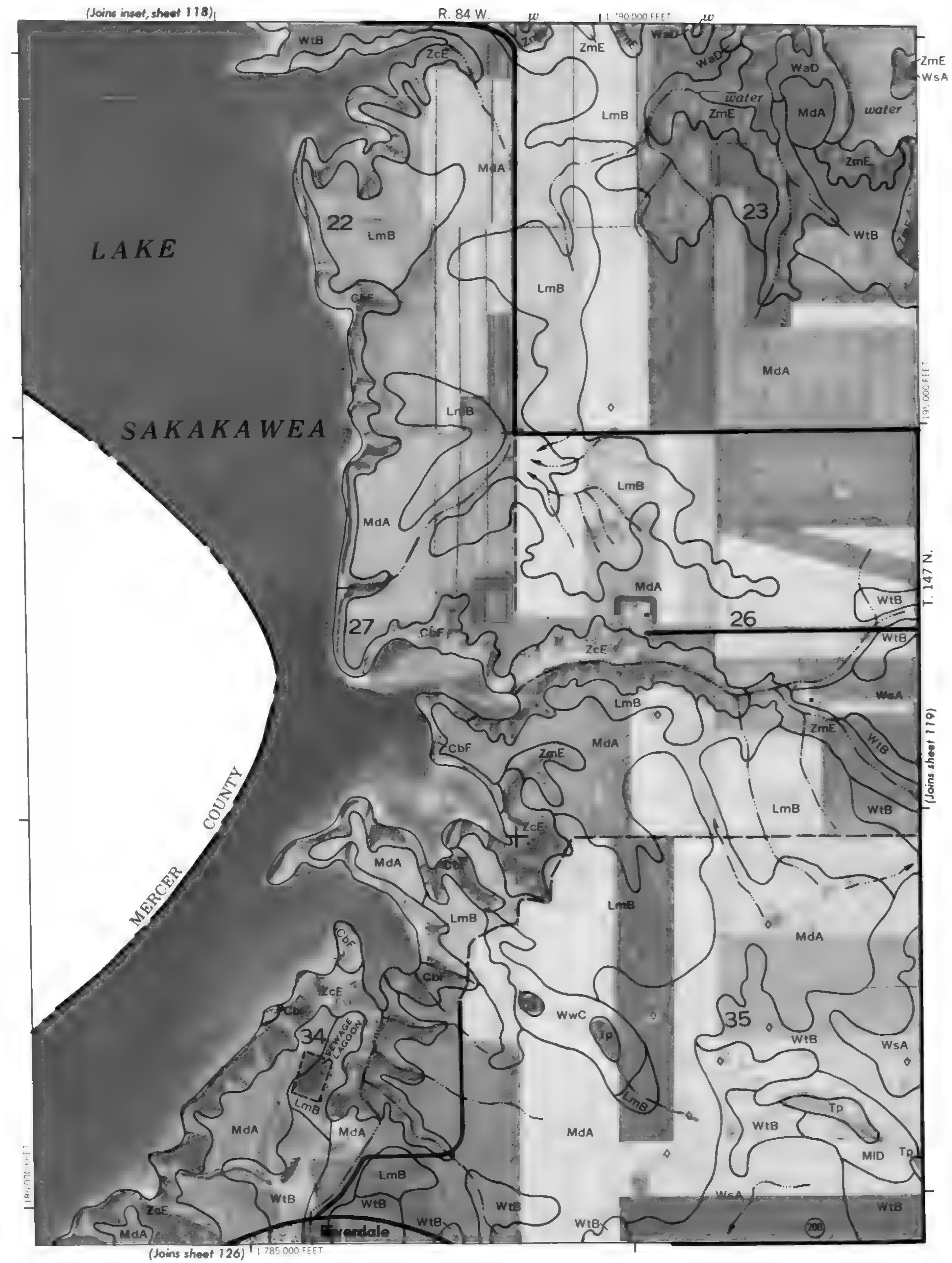

115
N
1 890 000 FEET
R. 81 W.
R. 80 W.
(Joins sheet 102)
215 000 FEET
T. 147 N.
(Joins sheet 114)
(Joins sheet 116)
(Joins sheet 123)
1 910 000 FEET
Nelson Lake
Lake Margaret
Lake Brekken
1
3
4
5
6
7
8
9
10
12
13
16
17
18
41
RxB
RzA
RsA
RtB
Dv
Mf
Pa
Af
WbB
WbD
WoB
WoC
MlD
MlC
RyC
PhA
PhB
PhC
ZmE
MgB
Tp
Hk
G.P.
Scale 1:20000
1 Mile
5000 Feet

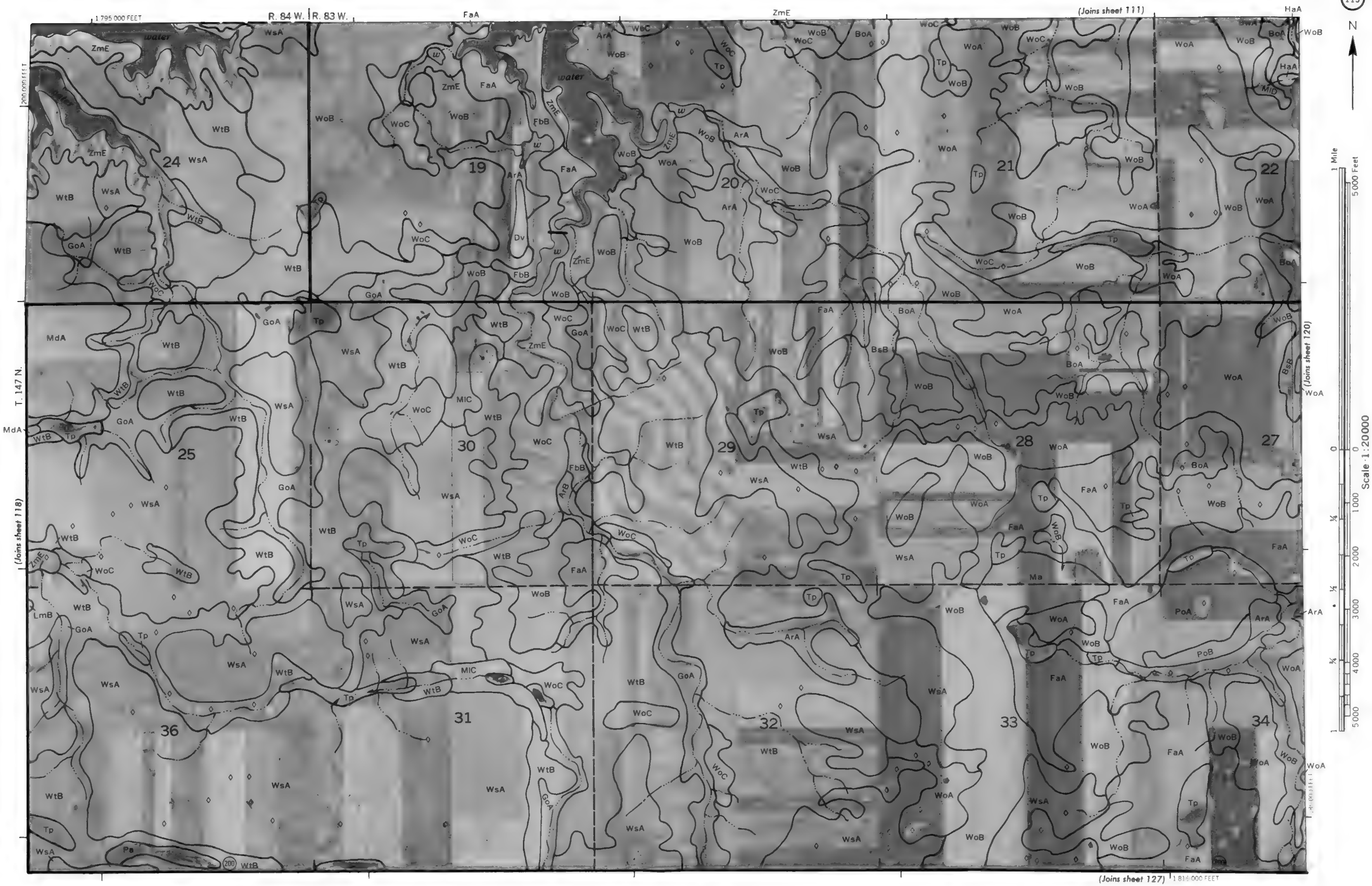

(Joins sheet 103)
R 80 W.
R 79 W
1 935 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
(Joins sheet 115)
(Joins sheet 117)
(Joins sheet 124)
T. 147 N.
Lake Margaret
Blue Lake
water
1
2
3
5
6
7
8
10
11
12
13
14
15
17
18
MIC
WoB
MgB
MID
Pa
ZmE
PhB
FnB
RxB
RtB
WbB
WbD
WaD
HaA
RzA
ArB
PhA
PhC
ArC
Af
Ma
Mf
FbA
Co
Hk
RsA
RyC
WoA
WpB
FnC
PoB


R. 79 W.
(Joins sheet 104)
T. 147 N.
(Joins sheet 116)
SHERIDAN COUNTY
(Joins sheet 125)
Blue Lake
N
1 Mile
5000 Feet
Scale 1:20000
1 940 000 FEET
1 960 000 FEET
210 000 FEET
200 000 FEET
1
2
3
4
9
10
11
12
13
14
15
16

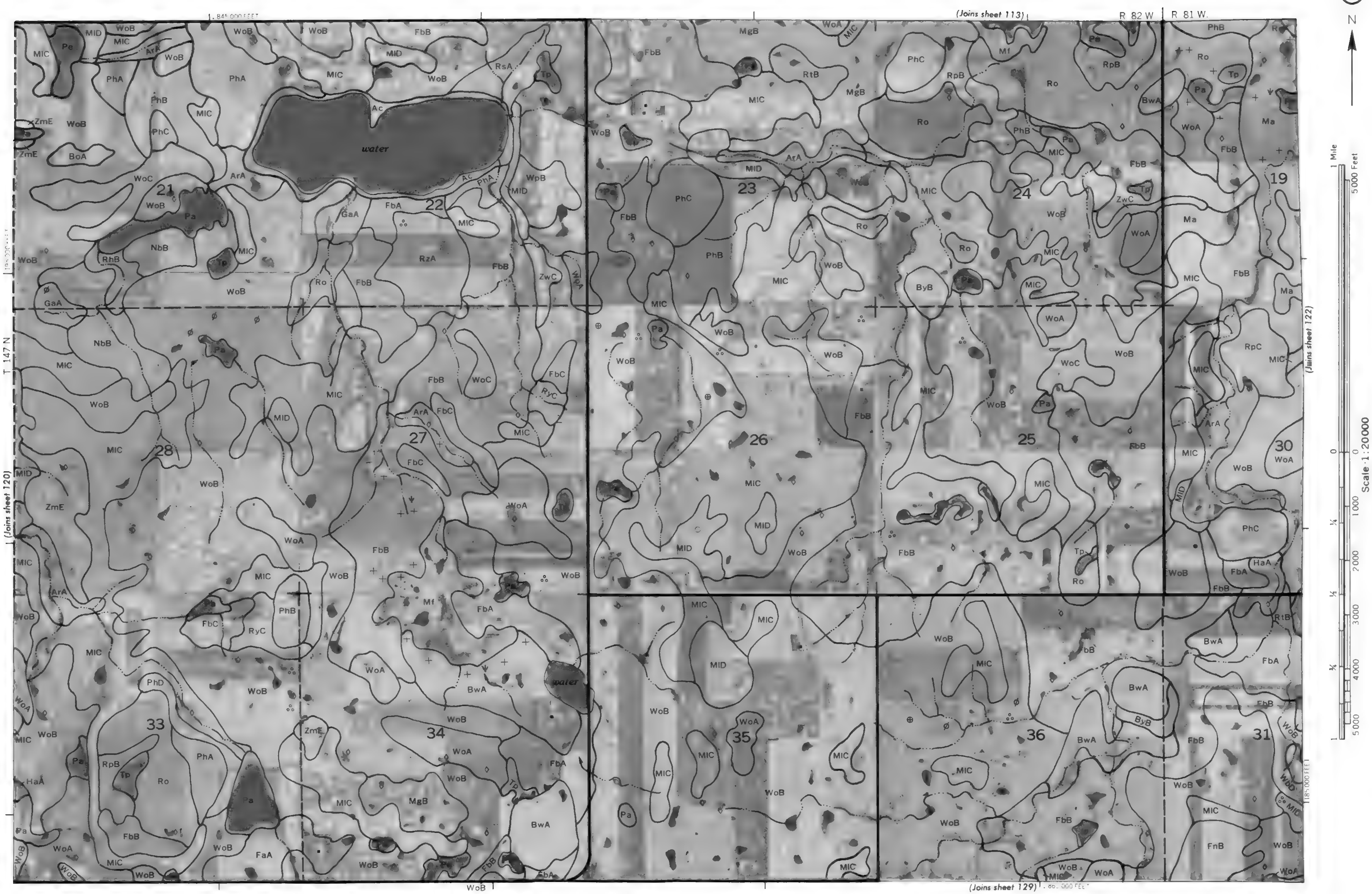

118
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000

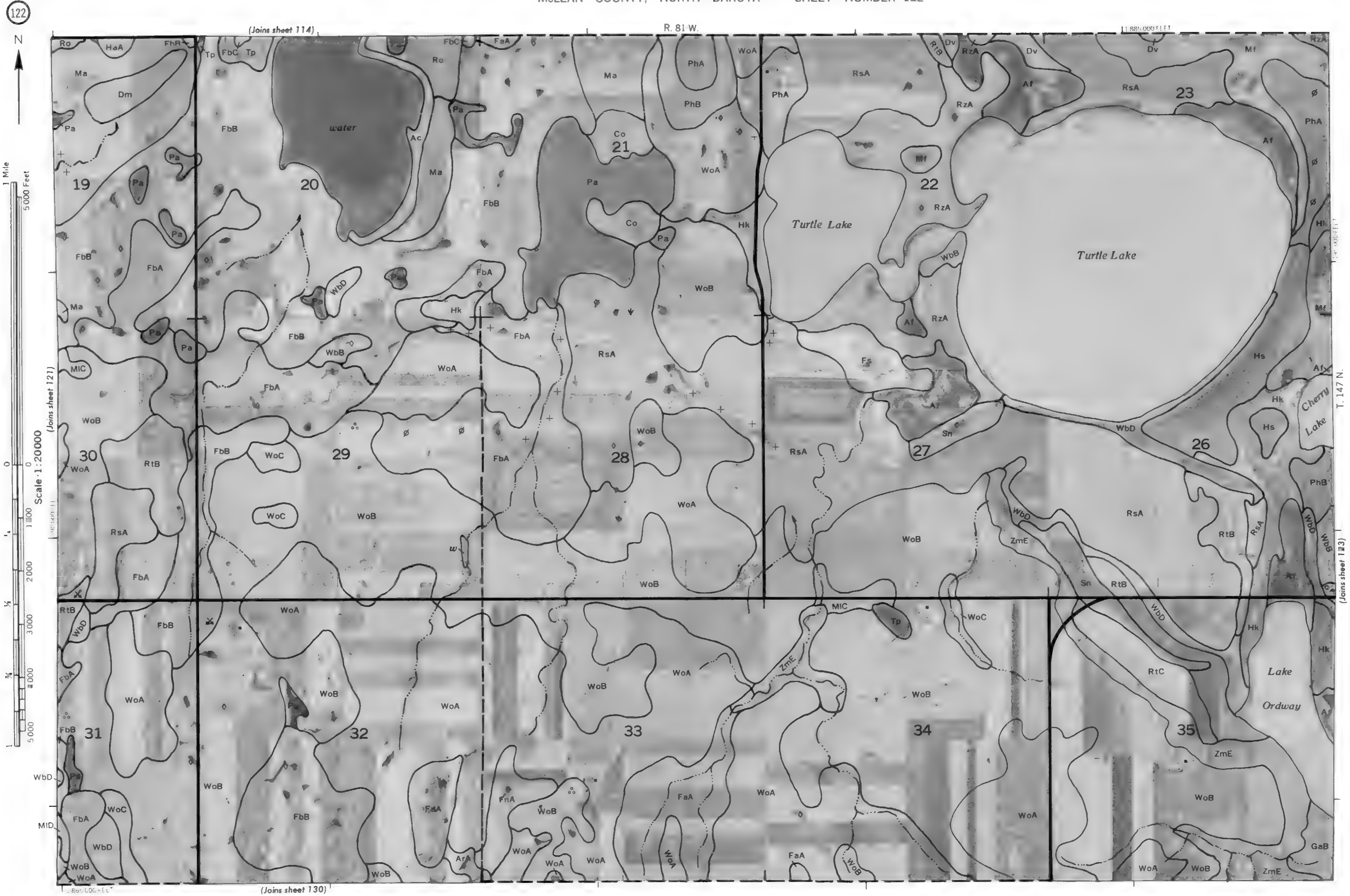

R. 84 W.
1 790 000 FEET
T. 147 N.
(Joins sheet 111)
(Joins sheet 118)
1 785 000 FEET
LAKE
SAKAKAWEA
11
ZmE
WoC
WoB
MlD
BoA
MlC
Tp
WtB
MdA
LmB
WaD


(Joins inset, sheet 118)
R. 84 W.
1 790 000 FEET
T. 147 N.
(Joins sheet 119)
(Joins sheet 126)
1 785 000 FEET
LAKE
SAKAKAWEA
MERCER
COUNTY
22
23
26
27
34
35
water
SEWAGE LAGOON
Riverdale
200
WtB
ZcE
ZmE
WaD
WsA
MdA
LmB
CbF
WwC
Tp
MlD
WaA


1 795 000 FEET
R. 84 W.
R. 83 W.
(Joins sheet 111)
(Joins sheet 120)
(Joins sheet 118)
(Joins sheet 127)
1 815 000 FEET
200 000 FEET
T. 147 N.
N
Scale 1:20000
1 Mile
5000 Feet
water
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36

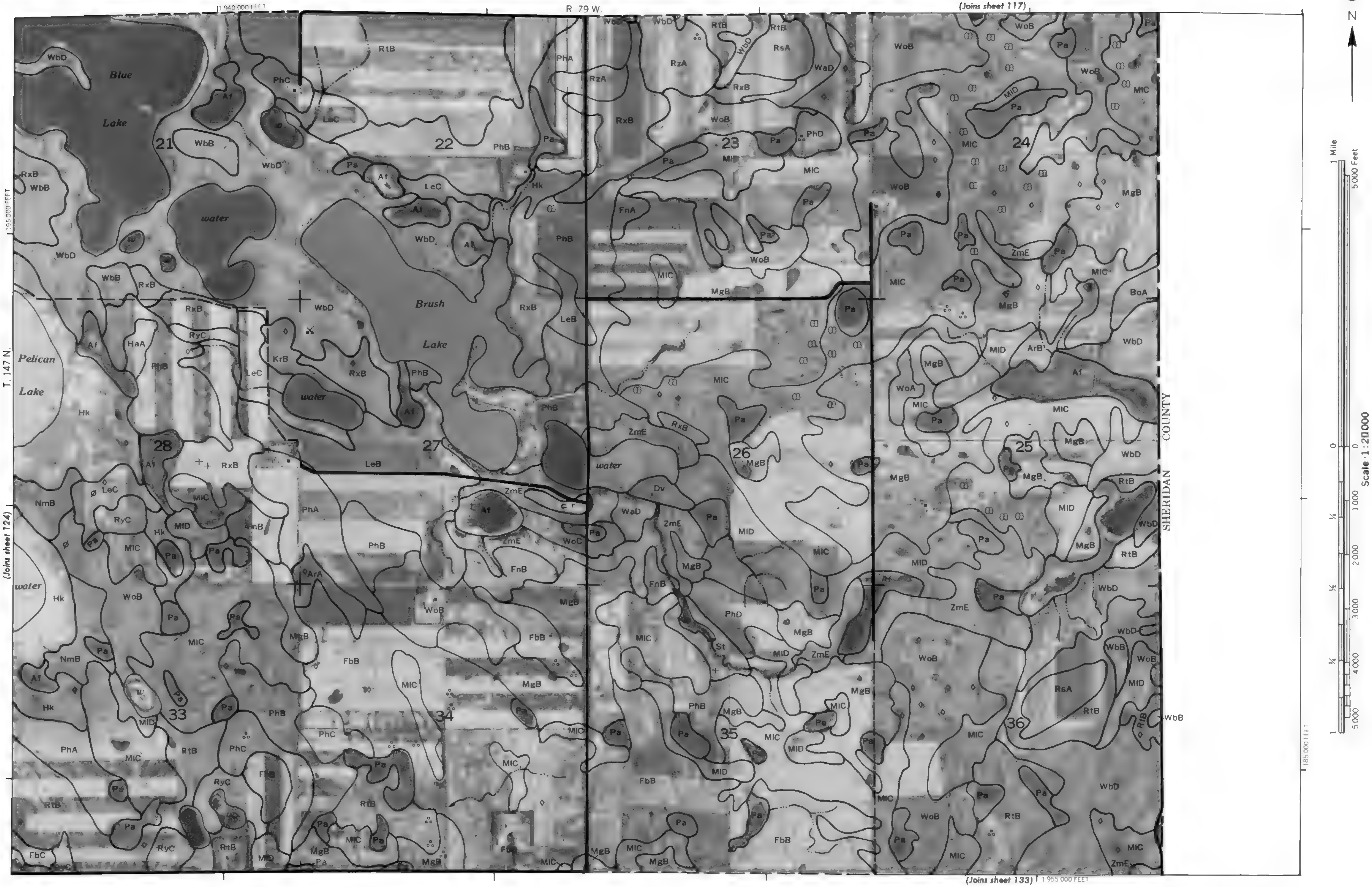

120
N
(Joins sheet 112)
R. 83 W. | R. 82 W.
1 840 000 FEET
(Joins sheet 119)
(Joins sheet 121)
(Joins sheet 128)
T. 147 N.
Scale 1:20000
1 Mile
5000 Feet
Coleharbor
SOO LINE
water

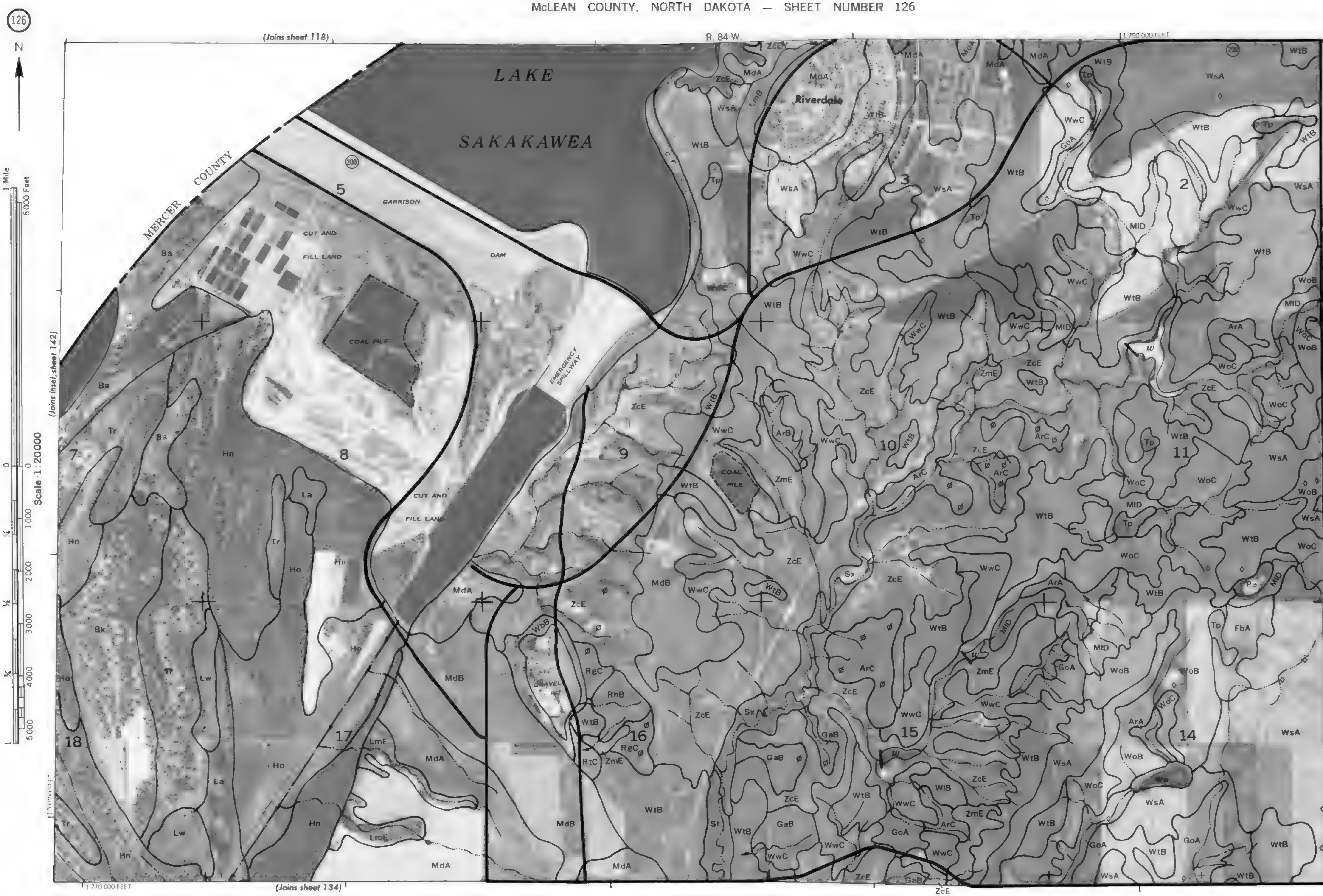

121
N
(Joins sheet 113)
R. 82 W. | R. 81 W.
(Joins sheet 122)
(Joins sheet 129)
(Joins sheet 120)
T. 147 N.
1 845 000 FEET
185 000 FEET
1 Mile
5000 Feet
0
Scale 1:20000
1000
2000
3000
4000
5000
19
21
22
23
24
25
26
27
28
30
31
33
34
35
36
water


122
N
(Joins sheet 114)
R. 81 W.
1 880 000 FEET
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 121)
(Joins sheet 123)
(Joins sheet 130)
T. 147 N.
water
Turtle Lake
Turtle Lake
Cherry Lake
Lake Ordway
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35
Ro
HaA
FhB
Ma
Dm
Pa
FbB
FbA
MIC
WoB
WoA
RtB
RsA
WbD
WoC
MID
Tp
FbC
Ac
PhA
PhB
Co
Hk
RzA
Dv
Mf
Af
Hs
Fs
Sn
ZmE
RtC
GaB
FaA
ArA
WbB

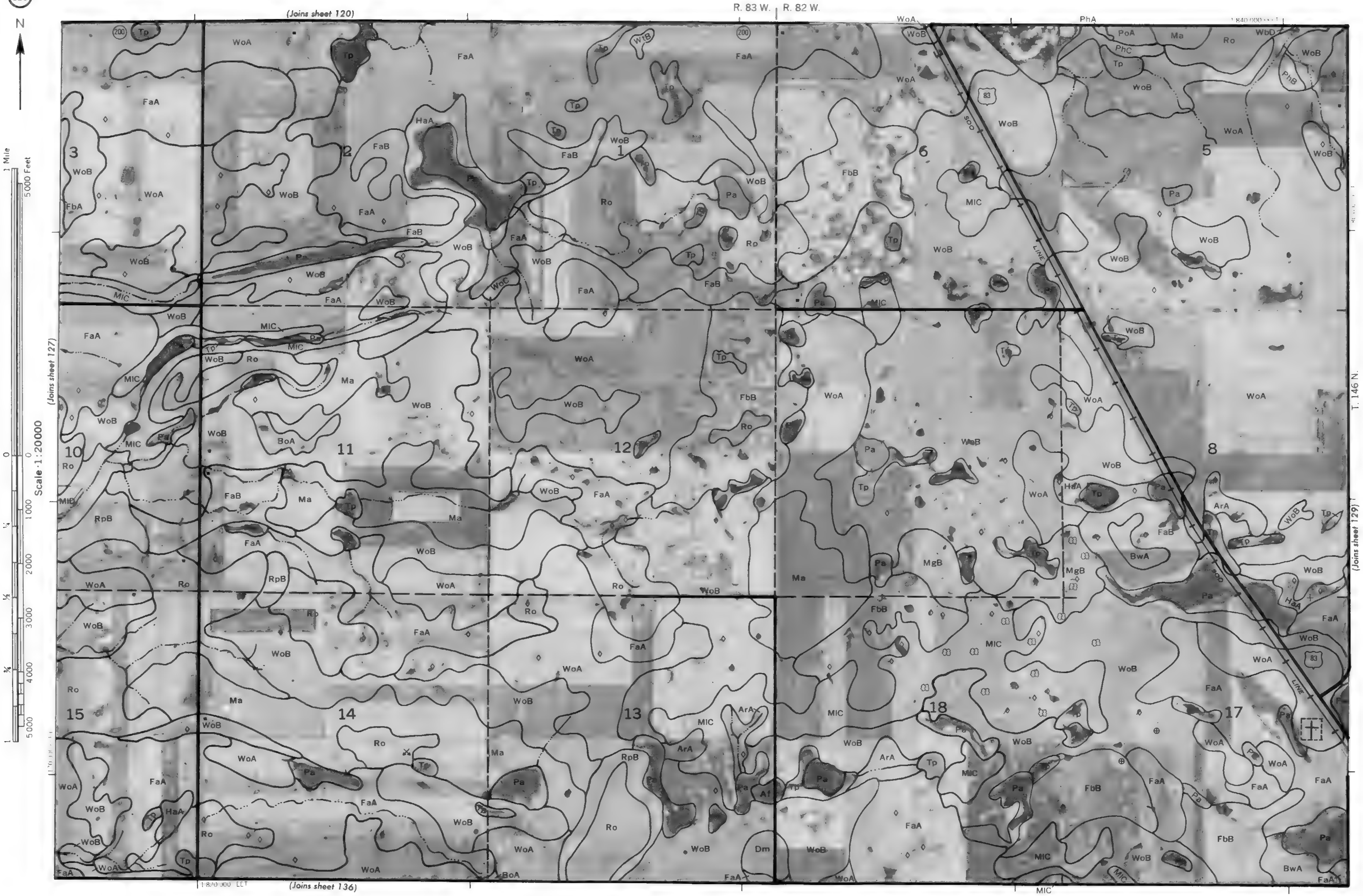

R. 81 W.
R. 80 W.
(Joins sheet 115)
(Joins sheet 122)
(Joins sheet 124)
(Joins sheet 131)
T. 147 N.
Lake Brekken
Lake Holmes
Cherry Lake
Lake Ordway
Turtle Lake
intermittent
water
SEWAGE LAGOON
GRAVEL PIT
BURLINGTON NORTHERN
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36
N
1 Mile
5000 Feet
Scale 1:20000

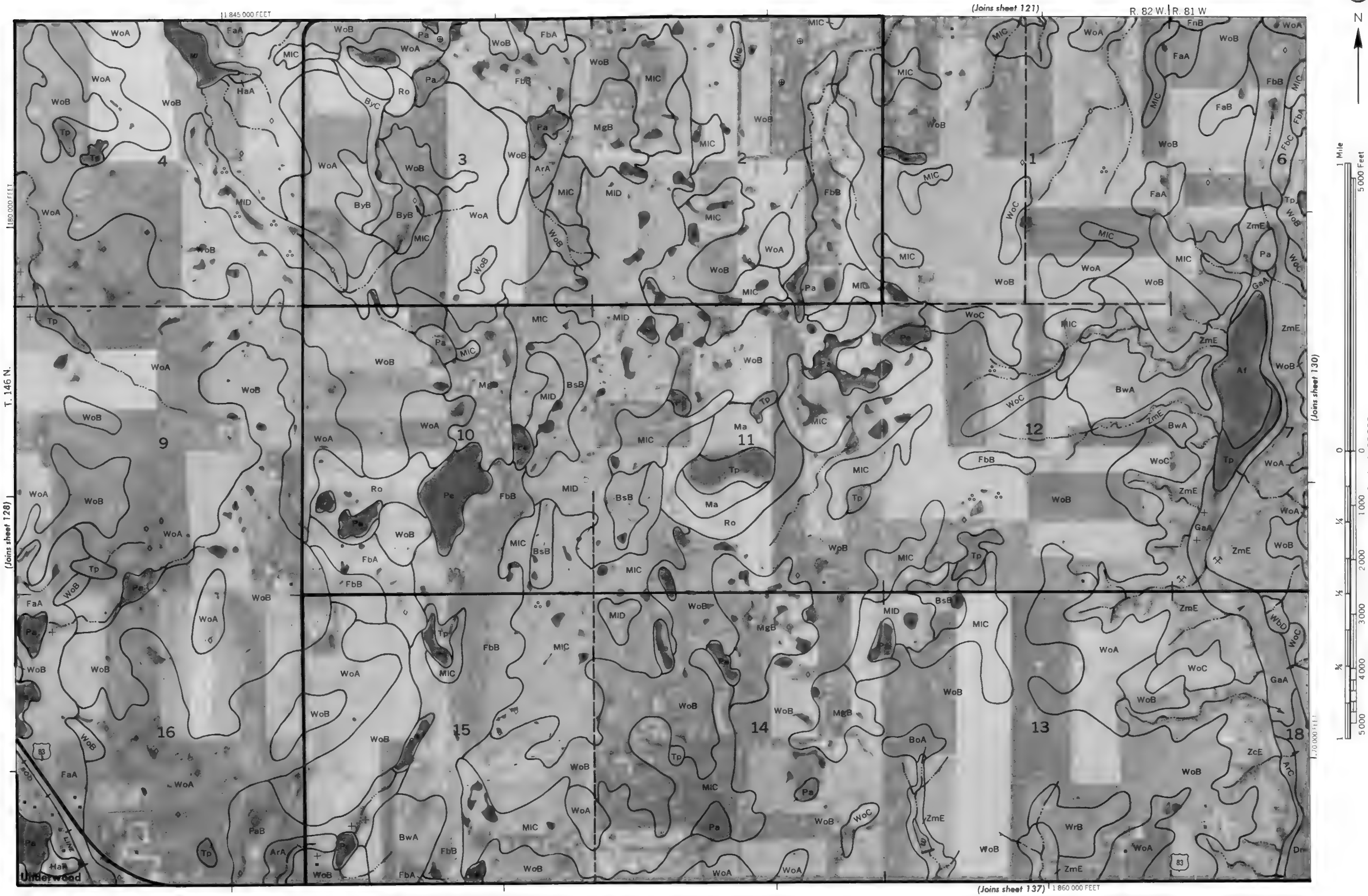

(Joins sheet 116)
R. 80 W. | R. 79 W.
1 935 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 123)
(Joins sheet 125)
(Joins sheet 132)
T. 147 N.
Lake Williams
Peterson Lake
Pelican Lake
Blue Lake
water
BURLINGTON NORTHERN
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32


1 940 000 FEET
R. 79 W.
(Joins sheet 117)
T. 147 N.
(Joins sheet 124)
(Joins sheet 133)
1 955 000 FEET
195 000 FEET
185 000 FEET
SHERIDAN COUNTY
Blue Lake
Brush Lake
Pelican Lake
water
21
22
23
24
25
26
27
28
33
34
35
36
N
1 Mile
5000 Feet
Scale 1:20000

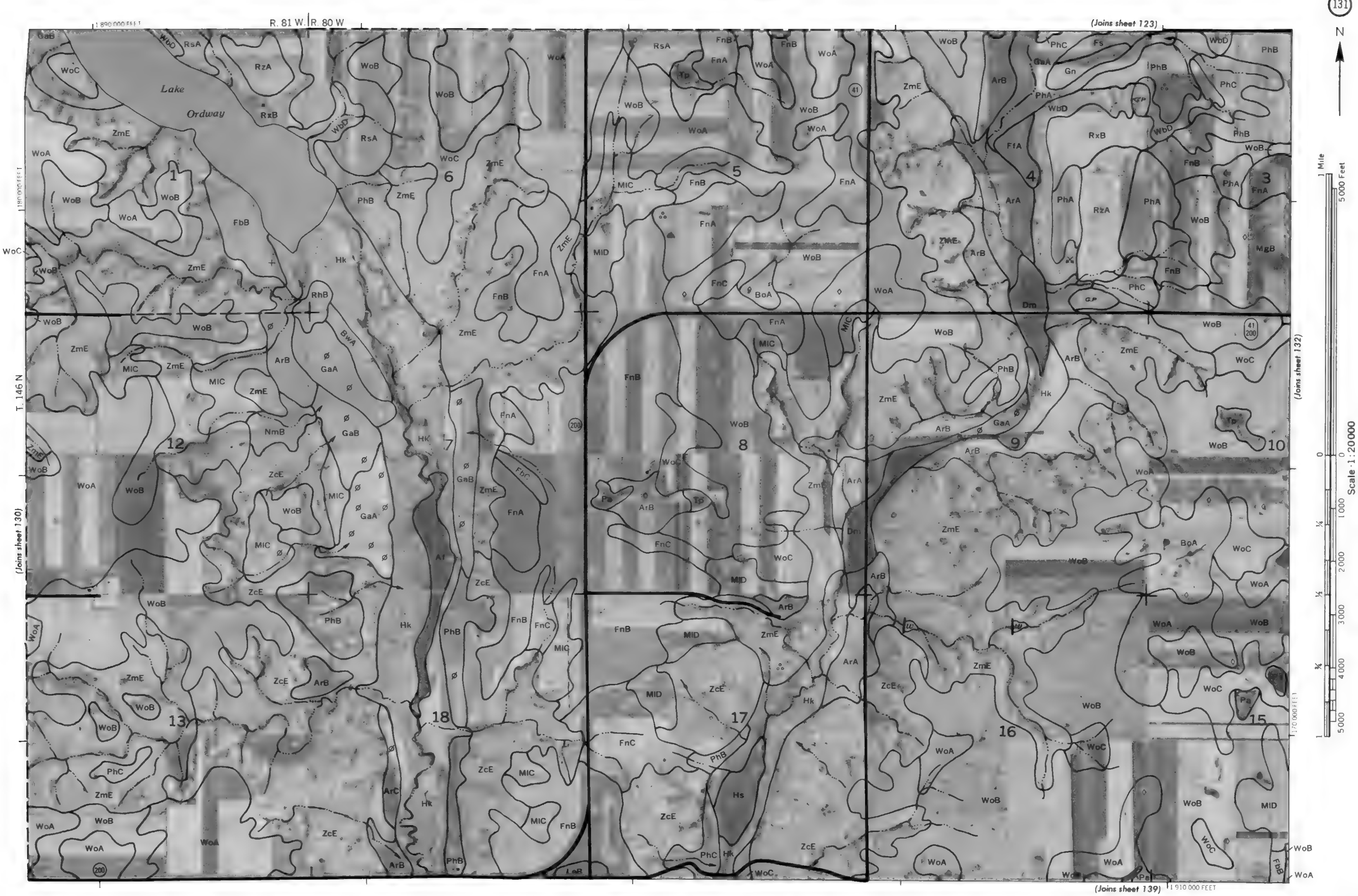

126
N
(Joins sheet 118)
R. 84 W.
1 790 000 FEET
LAKE
SAKAKAWEA
Riverdale
MERCER COUNTY
GARRISON
DAM
CUT AND
FILL LAND
COAL PILE
EMERGENCY SPILLWAY
CUT AND
FILL LAND
COAL
PILE
GRAVEL
PIT
(Joins inset, sheet 142)
(Joins sheet 127)
(Joins sheet 134)
1 770 000 FEET
180 000 FEET
T. 147 N.
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
1/4
1/2
3/4
1
200
2
3
5
7
8
9
10
11
14
15
16
17
18

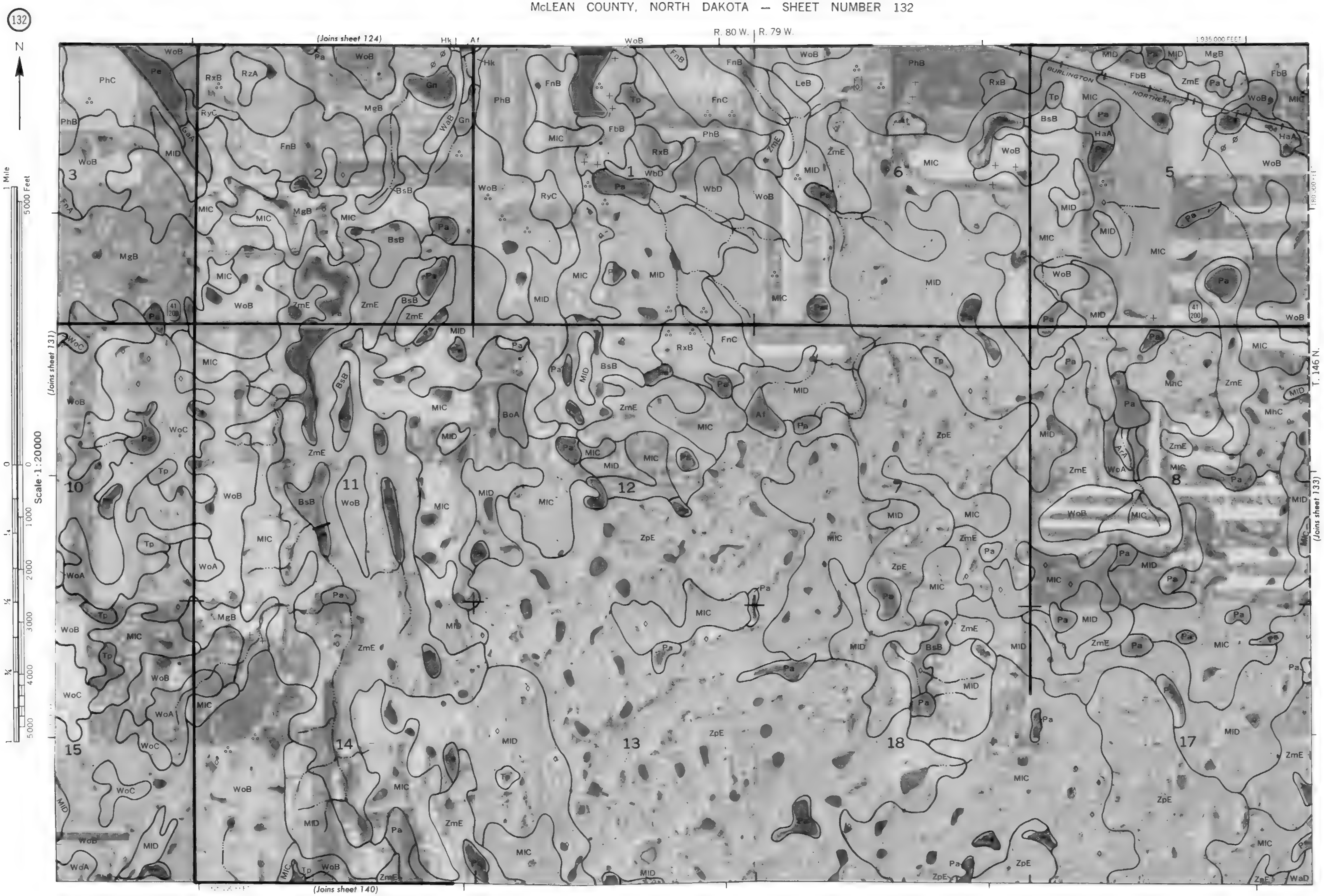

127
N
R. 84 W.
R. 83 W.
(Joins sheet 119)
(Joins sheet 126)
(Joins sheet 128)
(Joins sheet 135)
T. 146 N.
1 790 000 FEET
1 815 000 FEET
170 000 FEET
1 Mile
5000 Feet
Scale 1:20000
1
3
4
5
6
7
8
10
12
13
15
16
17
18
water


128
N
(Joins sheet 120)
R. 83 W.
R. 82 W.
(Joins sheet 127)
(Joins sheet 129)
(Joins sheet 136)
T. 146 N.
Scale 1:20000
1 Mile
5000 Feet
1000
2000
3000
4000
5000
1 840 000 FEET
1 820 000 FEET
1
2
3
5
6
8
10
11
12
13
14
15
17
18


129
N
(Joins sheet 121)
R. 82 W. | R. 81 W.
1 845 000 FEET
180 000 FEET
T. 146 N.
(Joins sheet 128)
(Joins sheet 130)
(Joins sheet 137)
1 860 000 FEET
1 Mile
5 000 Feet
Scale 1:20000
Underwood
4
3
2
1
6
9
10
11
12
7
16
15
14
13
18

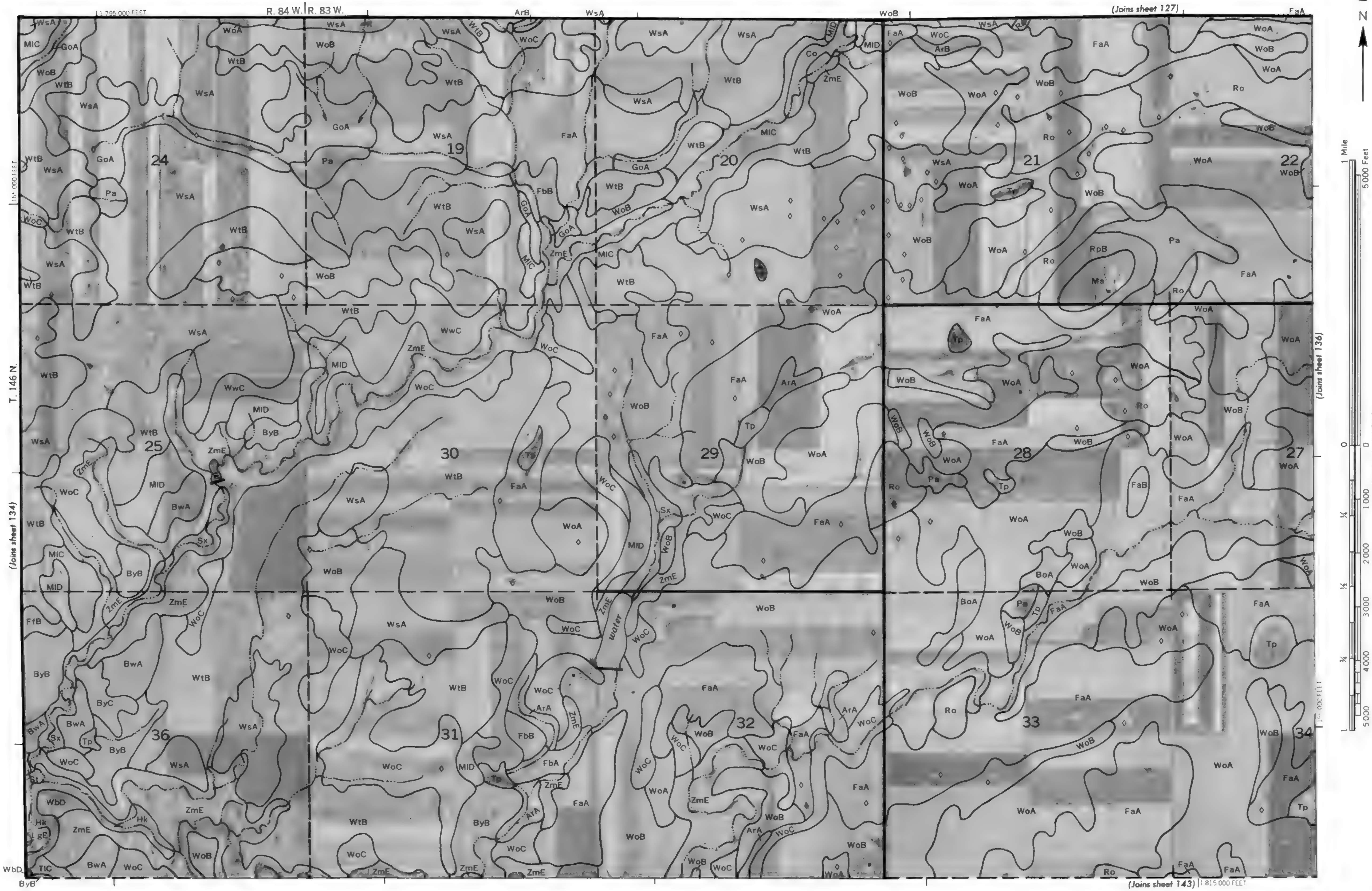

N
(Joins sheet 122)
R. 81 W.
(Joins sheet 129)
(Joins sheet 131)
(Joins sheet 138)
T. 146 N.
1 Mile
5 000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
6
5
4
3
2
7
8
9
10
11
18
17
16
15
14


131
N
R. 81 W. R. 80 W.
1 890 000 FEET
(Joins sheet 123)
(Joins sheet 132)
(Joins sheet 130)
(Joins sheet 139)
1 910 000 FEET
1 170 000 FEET
T. 146 N
Lake
Ordway
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
0
1000
2000
3000
4000
5000

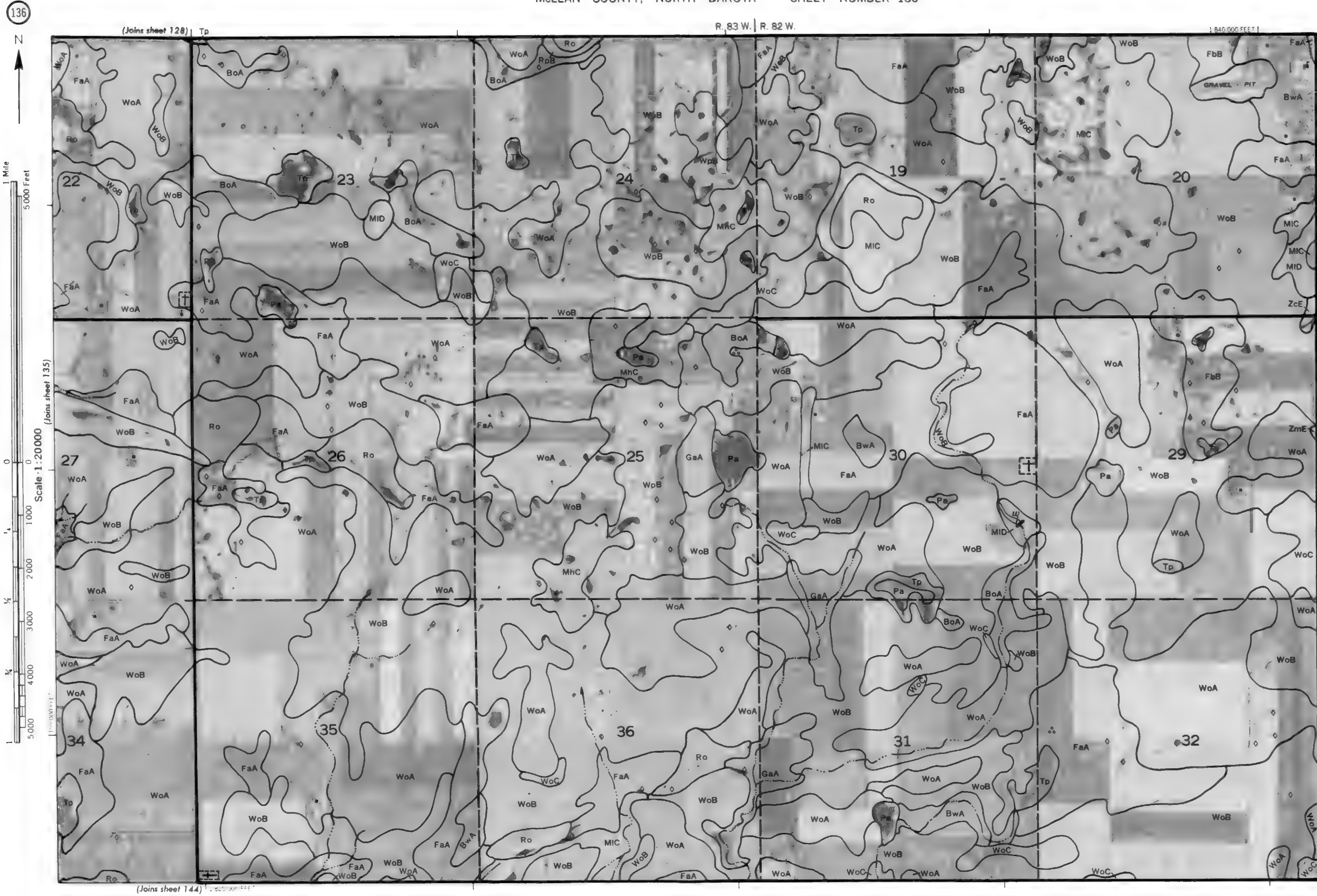

132
N
(Joins sheet 124)
(Joins sheet 131)
(Joins sheet 133)
(Joins sheet 140)
R. 80 W. | R. 79 W.
T. 146 N.
1 935 000 FEET
BURLINGTON NORTHERN
Scale 1:20000
1 Mile
5000 Feet
1
2
3
5
6
8
10
11
12
13
14
15
17
18


1 940 000 FEET
R. 79 W.
(Joins sheet 125)
N
180 000 FEET
T. 146 N.
(Joins sheet 132)
SHERIDAN COUNTY
BURLINGTON NORTHERN
(Joins sheet 141)
1 955 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
4
3
2
1
9
10
11
12
16
15
14
13

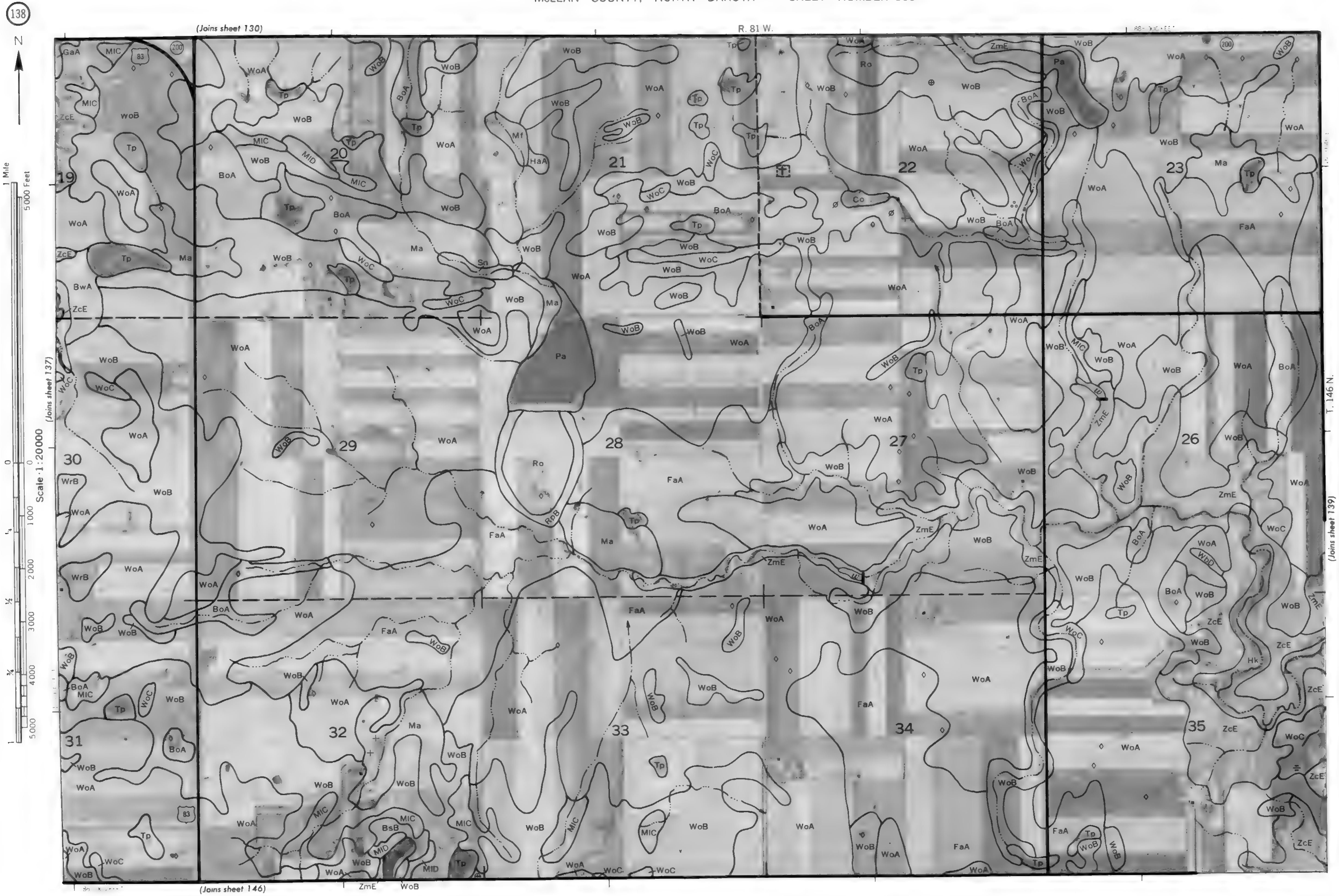

134
N
(Joins sheet 126)
R. 84 W.
1 790 000 FEET
(Joins inset, sheet 142)
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
155 000 FEET
165 000 FEET
T. 146 N.
(Joins sheet 135)
(Joins sheet 142)
1 770 000 FEET
MISSOURI
RIVER
MERCER
COUNTY
SEWAGE LAGOON
CUT AND FILL LAND
19
20
21
22
23
26
27
28
29
33
34
35


R. 84 W. | R. 83 W.
T. 146 N.
(Joins sheet 127)
(Joins sheet 136)
(Joins sheet 134)
(Joins sheet 143)
N
1 Mile
5000 Feet
Scale 1:20000
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36
WsA
WoA
WoB
WoC
WtB
FaA
Ro
Pa
Tp
MID
ZmE
water

McLEAN COUNTY, NORTH DAKOTA — SHEET NUMBER 136



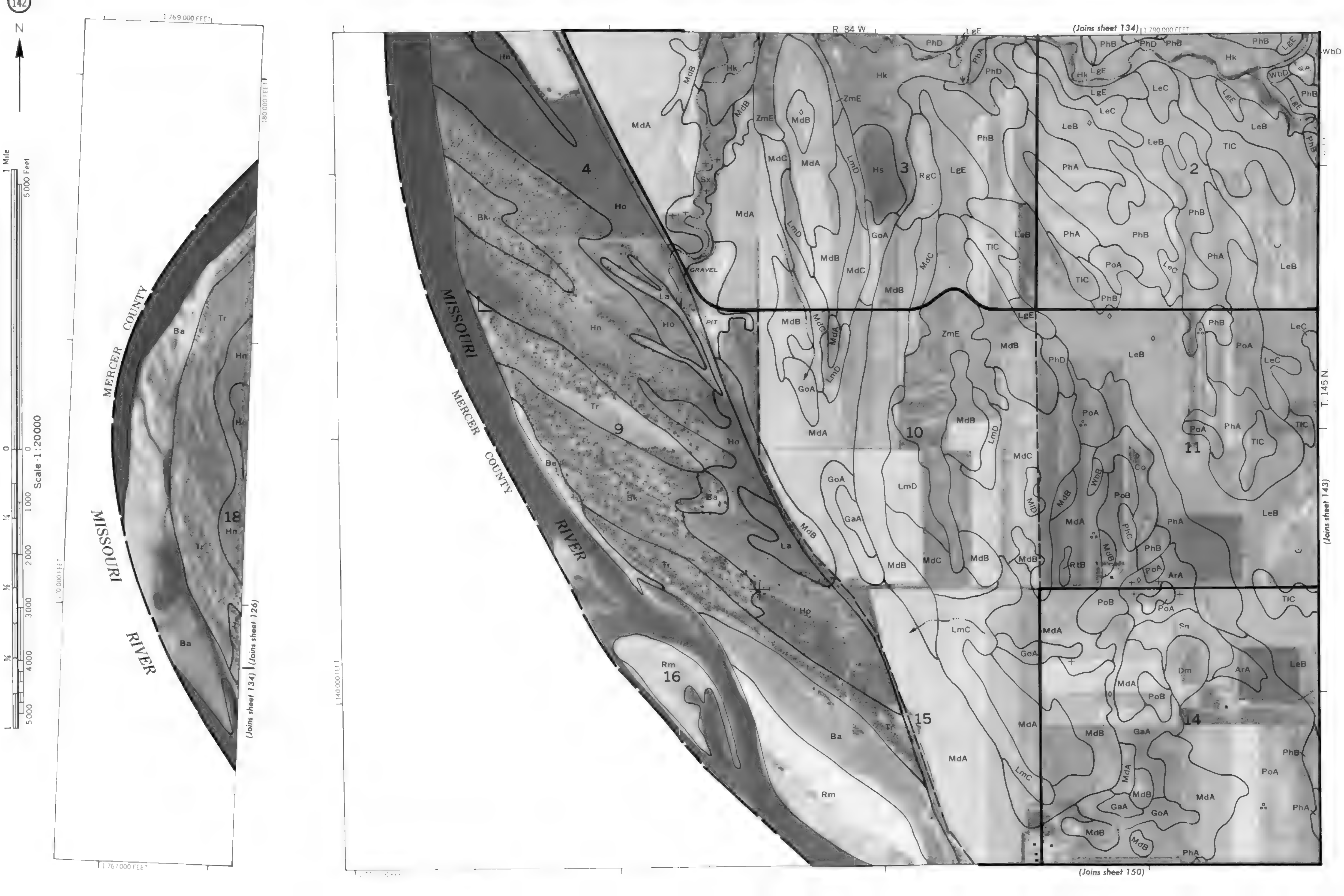

(Joins sheet 129)
R. 82 W.
R. 81 W.
N
Underwood
SEWAGE LAGOON
Coal
Lake
T. 146 N.
(Joins sheet 136)
(Joins sheet 138)
(Joins sheet 145)
1 845 000 FEET
1 860 000 FEET
SOO LINE
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
1 Mile
5000 Feet
Scale 1:20000


138
N
(Joins sheet 130)
R. 81 W.
(Joins sheet 137)
(Joins sheet 139)
(Joins sheet 146)
T. 146 N.
1 Mile
5000 Feet
Scale 1:20000
19
20
21
22
23
30
29
28
27
26
31
32
33
34
35

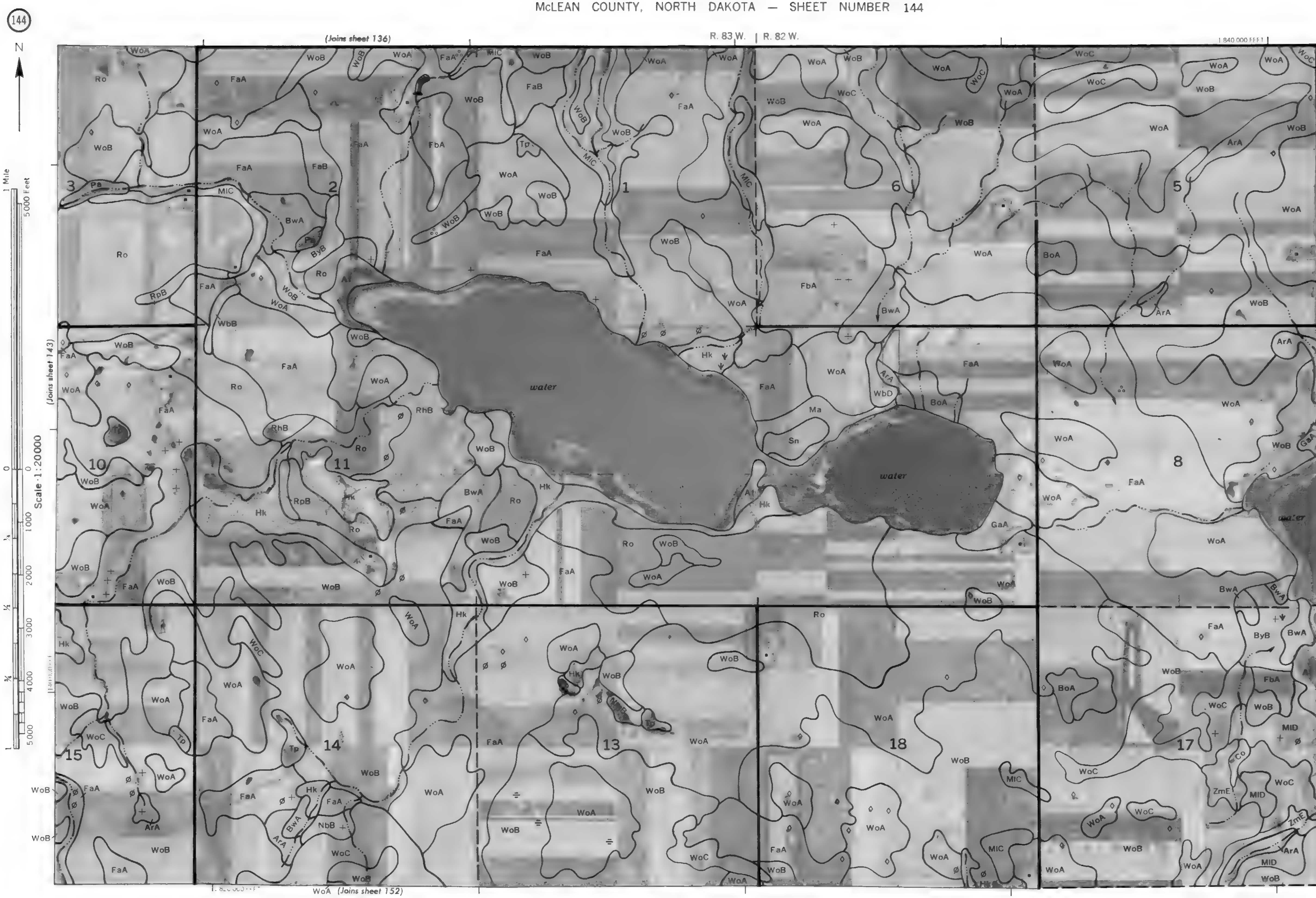

139
N
(Joins sheet 131)
(Joins sheet 138)
(Joins sheet 140)
(Joins sheet 147)
R. 81 W. | R. 80 W.
T. 146 N.
1 890 000 FEET
Scale 1:20000
1 Mile
5000 Feet
24
19
20
21
22
25
30
29
28
27
36
31
32
33
34
water
WoA
WoB
WoC
BoA
ZcE
MID
ArB
ArC
ArA
Hk
PhB
PhC
PhD
PhA
FnB
FnA
LeB
MoC
RgC
MIC
MgB
Pa
Tp
FbB
FbA
FbC
FbC
Ro
Sn
WIB
NbA
ZmE
WbD
WbB
RxB
Co
LgE
RzA
FIE
GaB
VwC
RsA
RtC
Ro

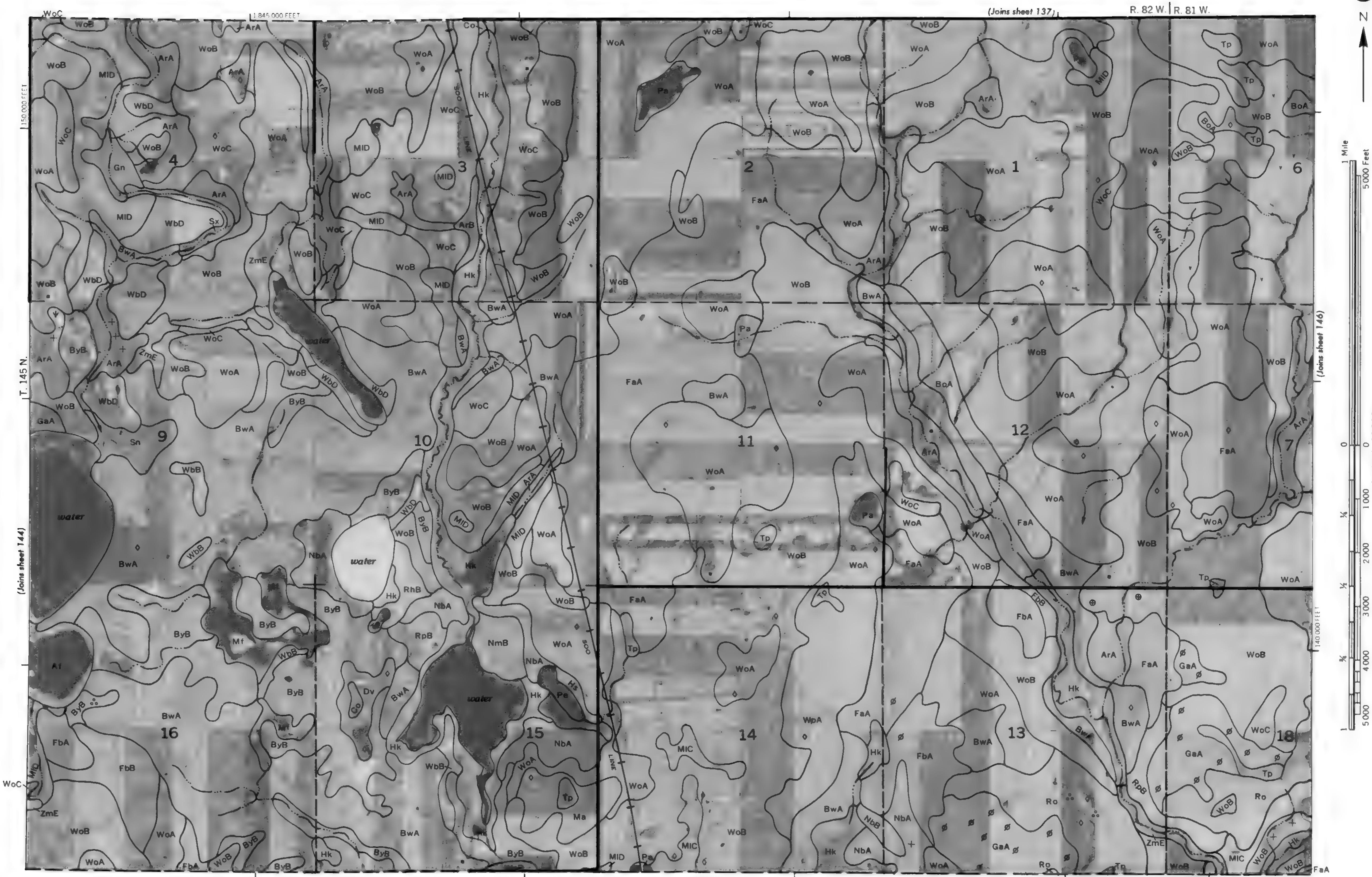

140
N
R. 80 W
R. 79 W
(Joins sheet 132)
(Joins sheet 139)
(Joins sheet 141)
(Joins sheet 148)
T. 146 N.
1 Mile
5000 Feet
Scale 1:20000
water
19
20
22
23
24
25
26
27
29
30
31
32
34
35
36

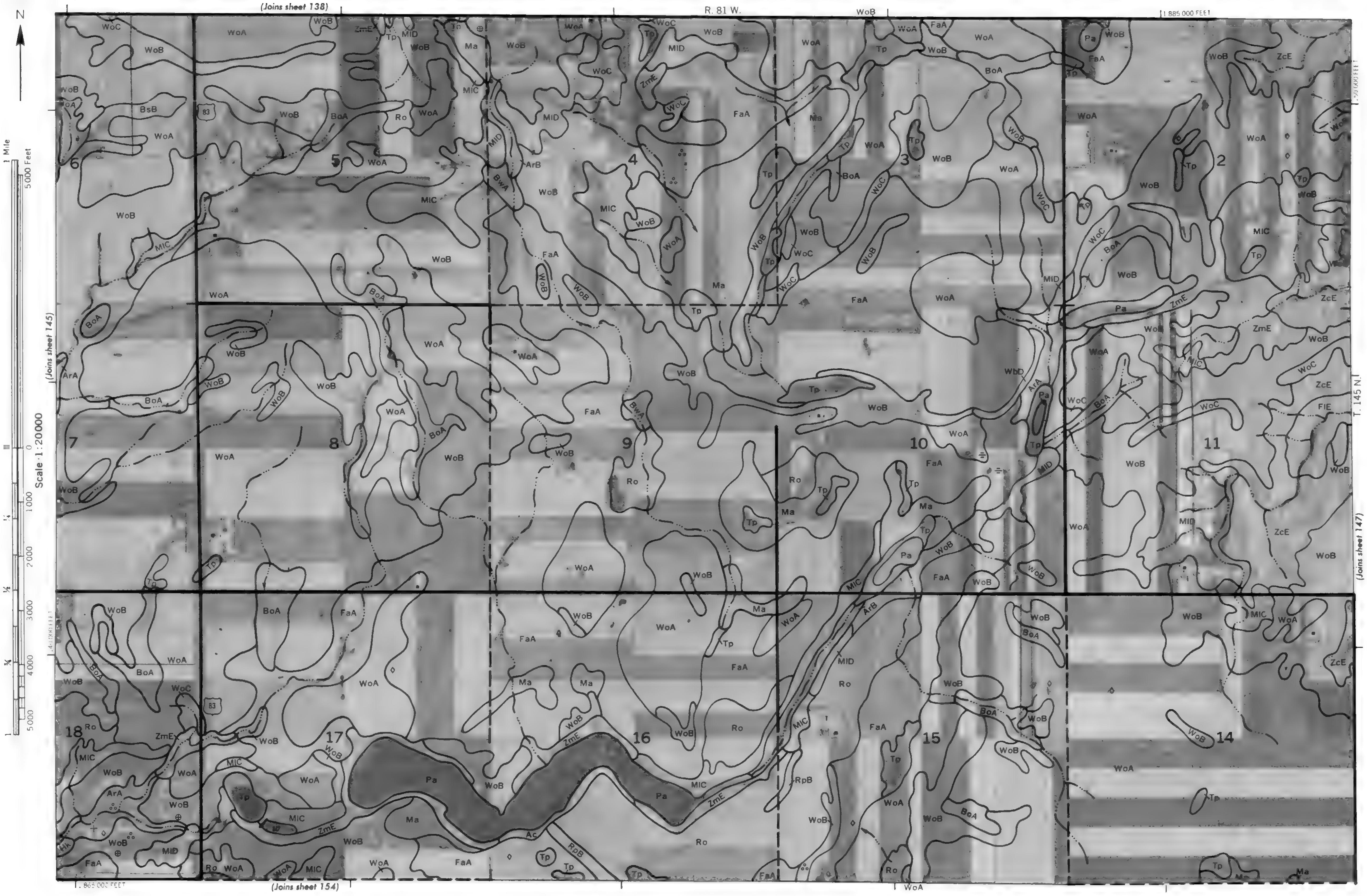
McLEAN COUNTY, NORTH DAKOTA — SHEET NUMBER 141

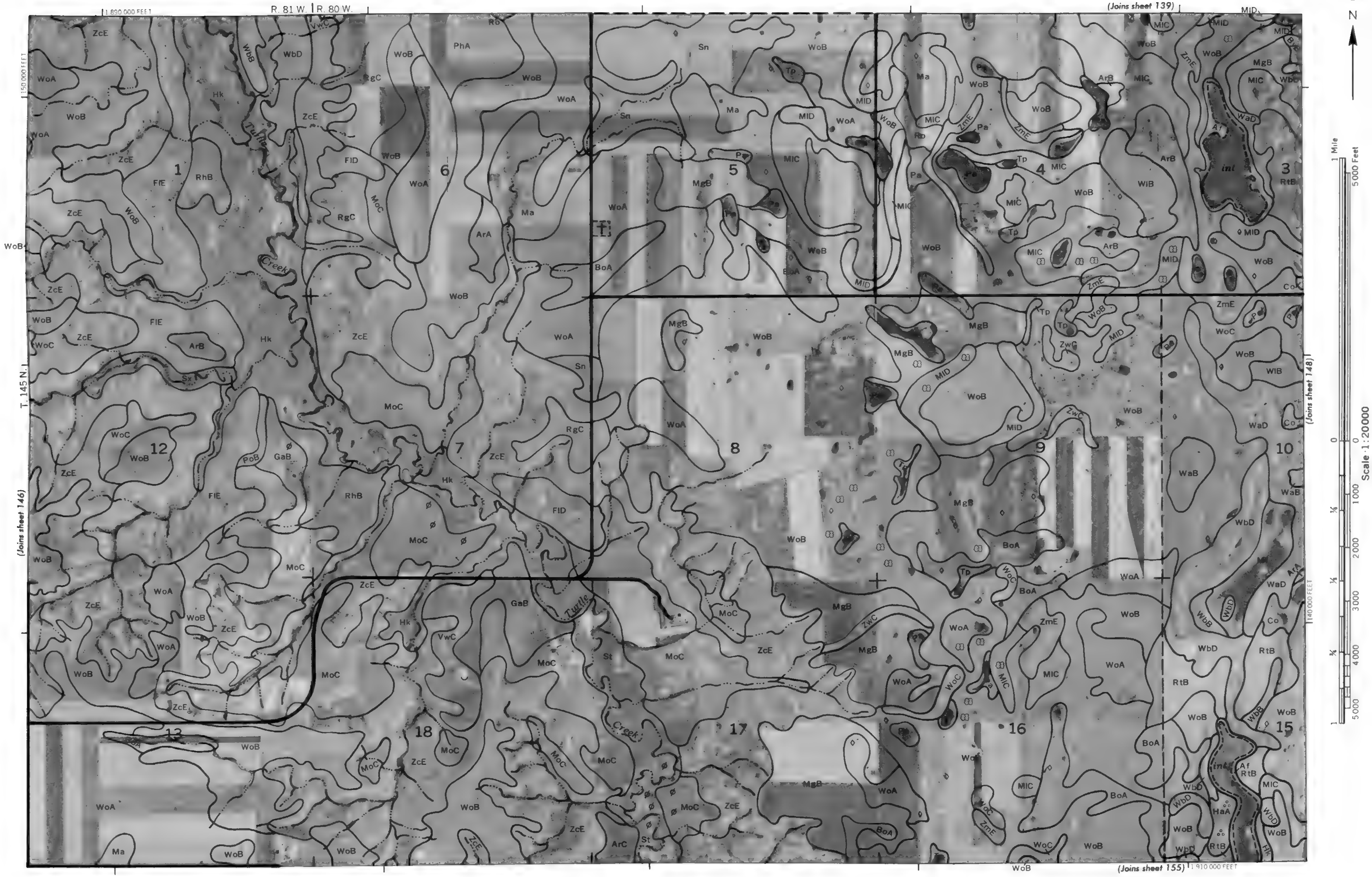

142
N
1 Mile
5000 Feet
Scale 1:20000
MISSOURI
RIVER
MERCER COUNTY
(Joins sheet 134)
(Joins sheet 126)
R. 84 W.
(Joins sheet 134)
1 790 000 FEET
T. 145 N.
(Joins sheet 143)
(Joins sheet 150)
1 769 000 FEET
1 767 000 FEET
140 000 FEET
GRAVEL
PIT
4
3
2
9
10
11
16
15
14
18
2000 AND 5000-FOOT GRID TICK


143
N
R. 84 W.
R. 83 W.
T. 145 N.
1 795 000 FEET
150 000 FEET
140 000 FEET
1 815 000 FEET
(Joins sheet 135)
(Joins sheet 142)
(Joins sheet 144)
(Joins sheet 151)
1 Mile
5000 Feet
Scale 1:20000
1
2
3
4
5
6
7
8
9
10
12
13
15
16
17
18
ByB
WoC
WoB
BwA
WbD
TlC
PhB
LgE
PhA
MID
WsA
WtB
ZmE
WwC
PhC
LeB
LeC
FnC
PoA
FnB
FbB
FaA
Tp
GoA
ArB
Hk
ArA
WoA
Ro
Pa
Dm
PoB
KrB
FnA
SeD
Fs
FaB
BoA

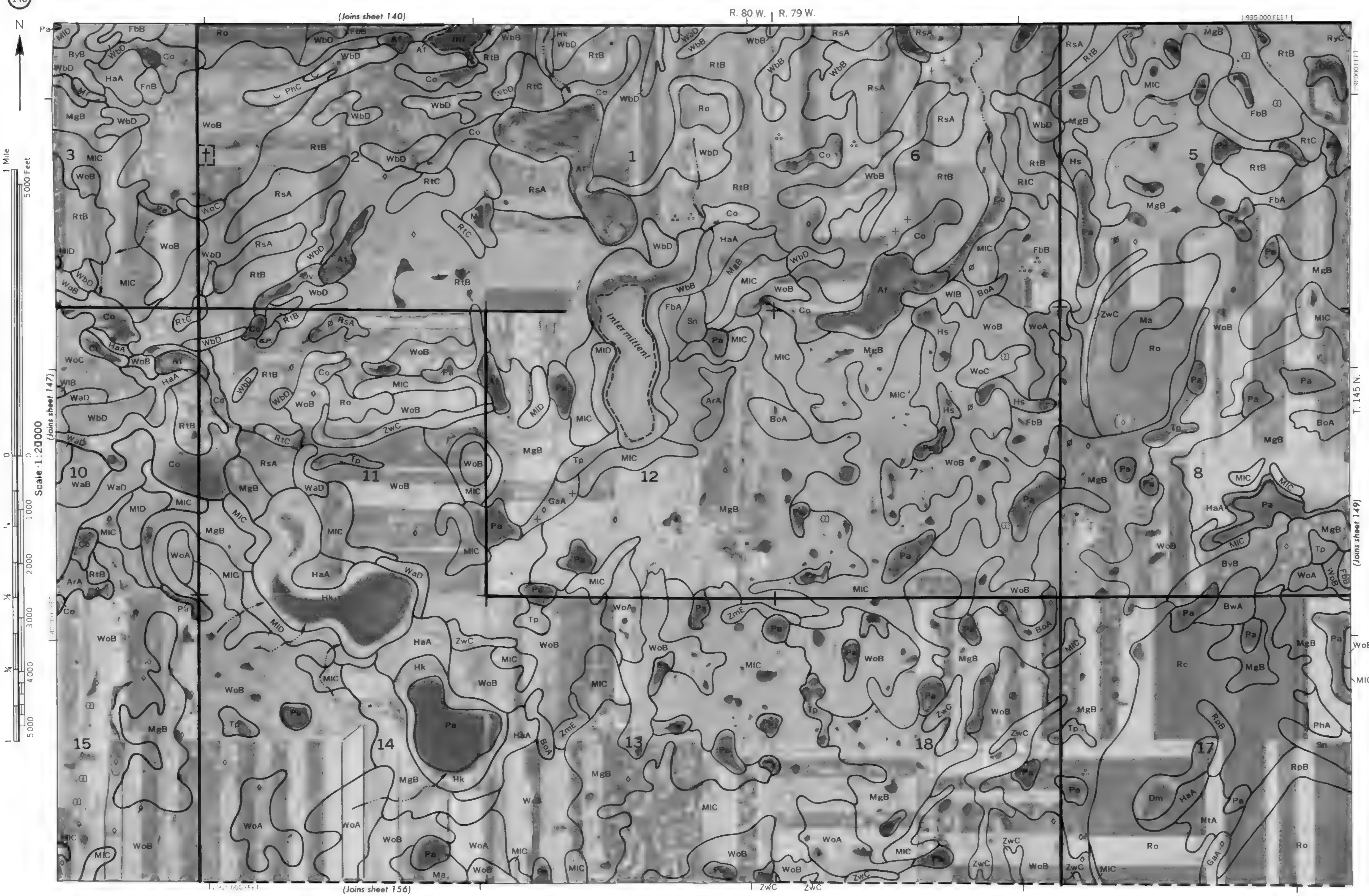

144
N
(Joins sheet 136)
R. 83 W.
R. 82 W.
1 840 000 FEET
(Joins sheet 143)
(Joins sheet 145)
T. 145 N
WoA (Joins sheet 152)
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
1
2
3
5
6
8
10
11
13
14
15
17
18
water
WoA
WoB
WoC
FaA
FaB
FbA
MIC
MID
Ro
Pa
BwA
ByB
RpB
RhB
Hk
Tp
ArA
AfA
BoA
WbD
Ma
Sn
GaA
NbB
ZmE
Co


(Joins sheet 137)
R. 82 W.
R. 81 W.
N
1 845 000 FEET
150 000 FEET
T. 145 N.
(Joins sheet 144)
(Joins sheet 146)
(Joins sheet 153)
1 860 000 FEET
140 000 FEET
1 Mile
5000 Feet
Scale 1:20000
1
2
3
4
6
7
9
10
11
12
13
14
15
16
18
water
SOO LINE

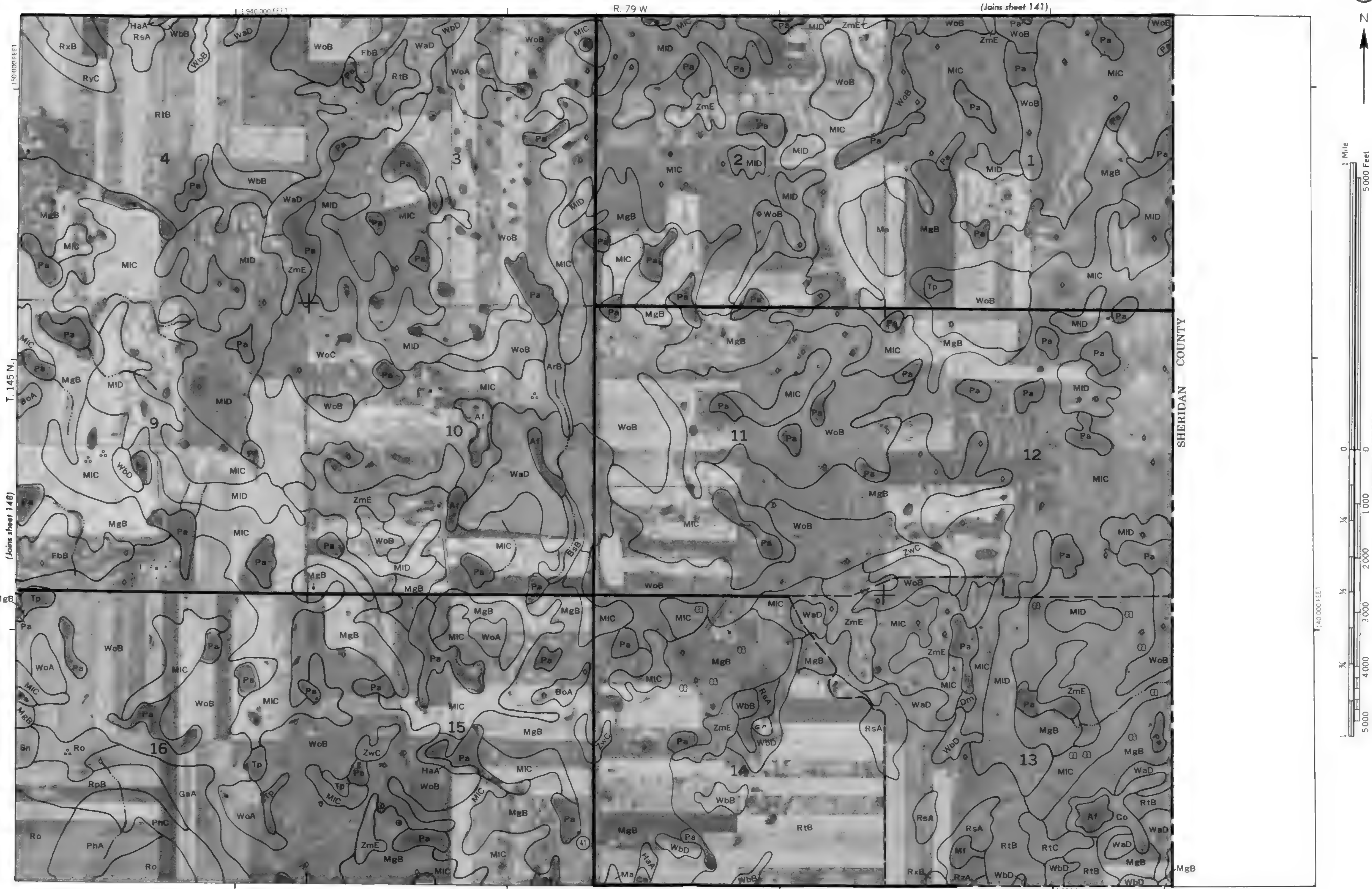

N
(Joins sheet 138)
R. 81 W.
1 885 000 FEET
(Joins sheet 145)
(Joins sheet 147)
T. 145 N.
(Joins sheet 154)
1 865 000 FEET
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
6
5
4
3
2
7
8
9
10
11
18
17
16
15
14

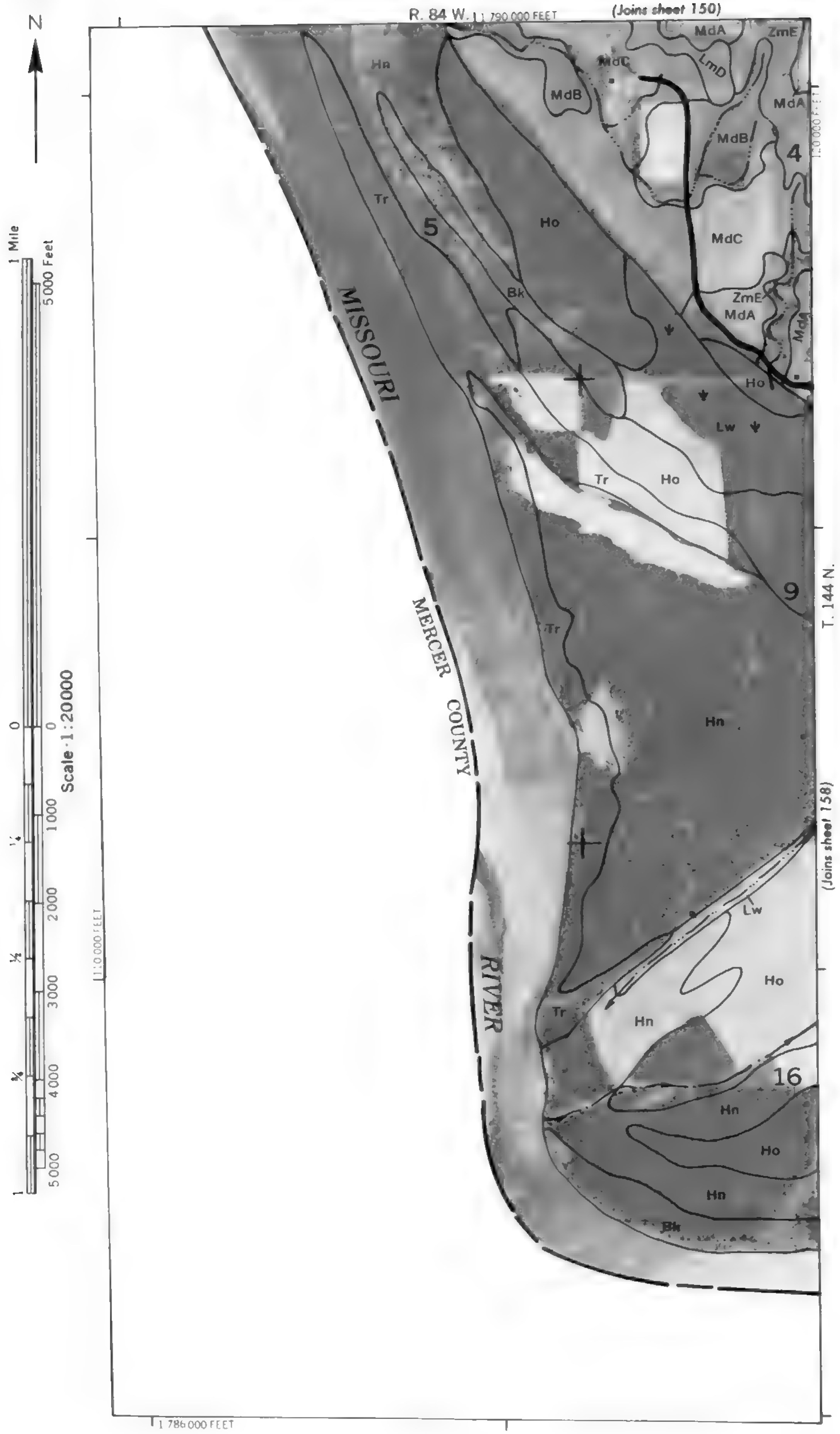

R. 81 W.
R. 80 W.
1 890 000 FEET
(Joins sheet 139)
T. 145 N.
(Joins sheet 146)
(Joins sheet 148)
(Joins sheet 155)
1 910 000 FEET
140 000 FEET
150 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
Turtle
Creek
1
3
4
5
6
7
8
9
10
12
13
15
16
17
18

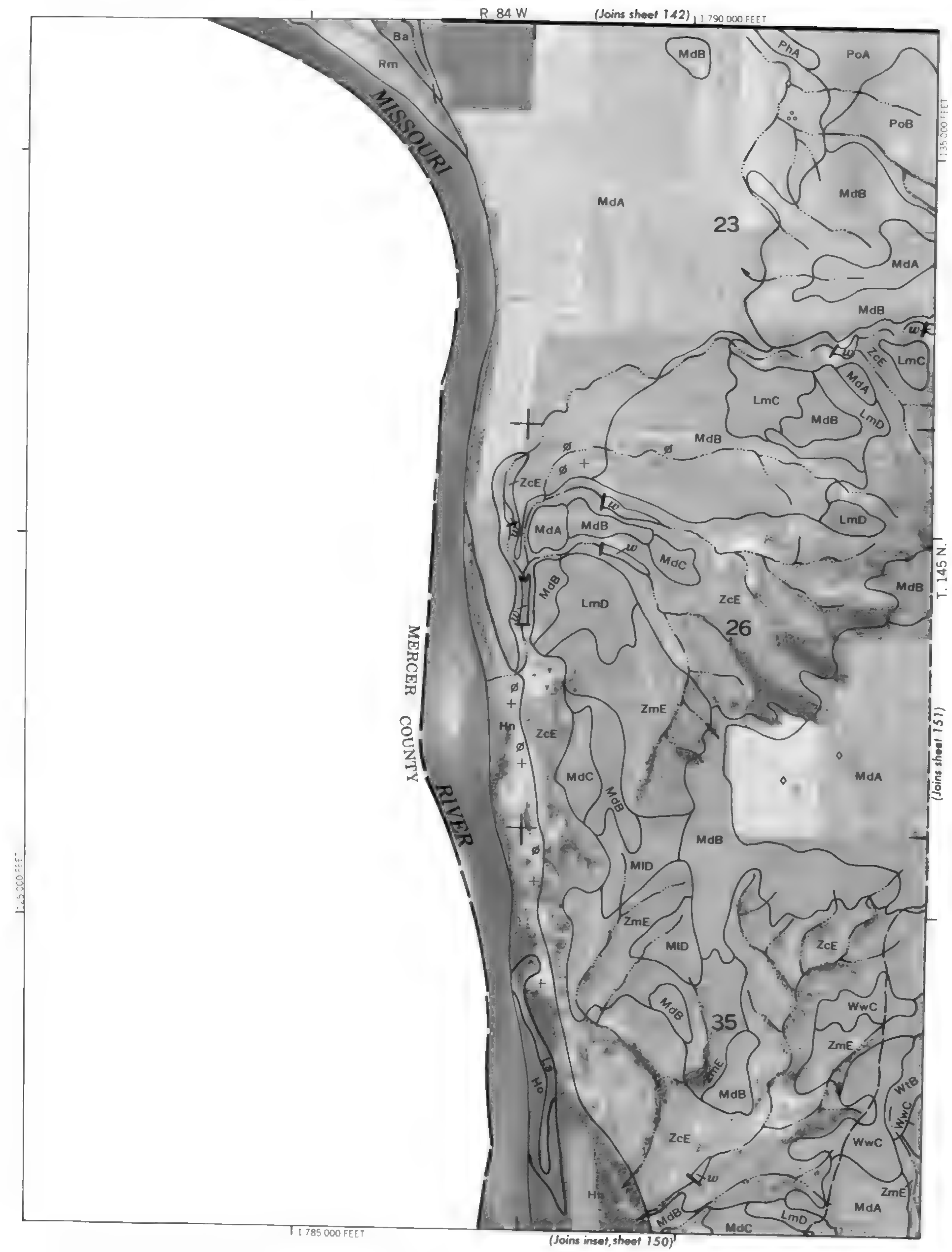
McLEAN COUNTY, NORTH DAKOTA — SHEET NUMBER 148

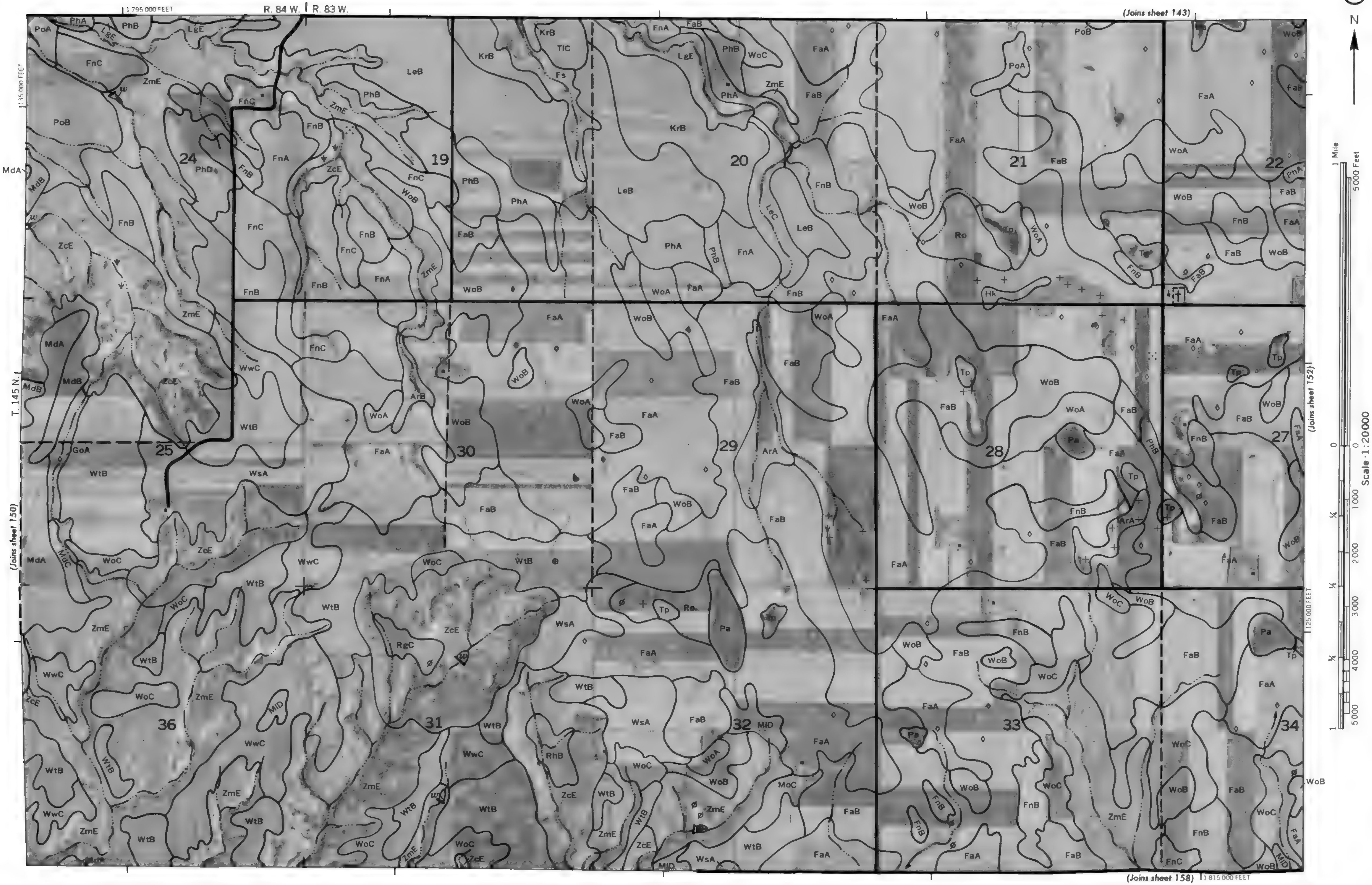


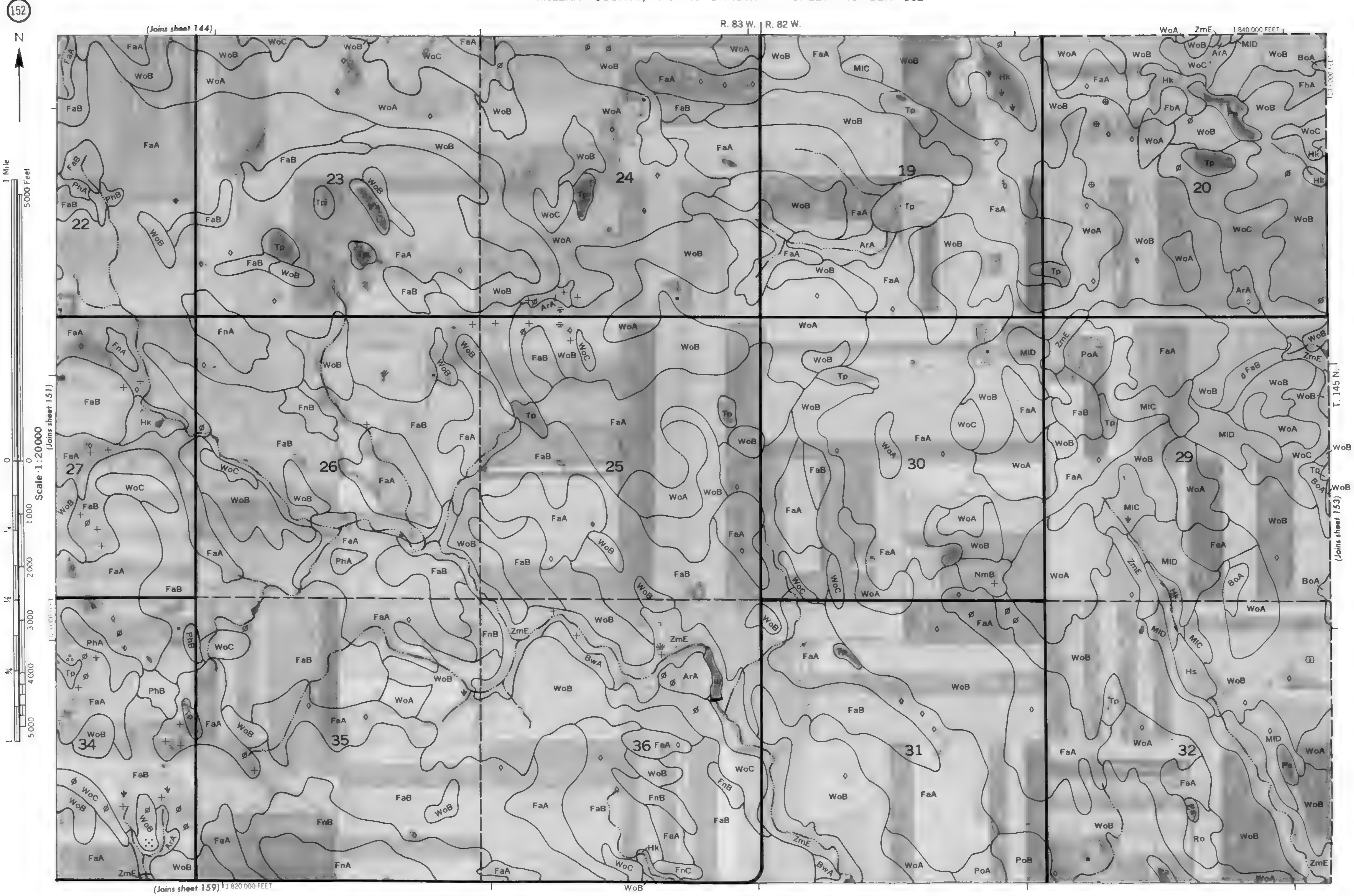
149

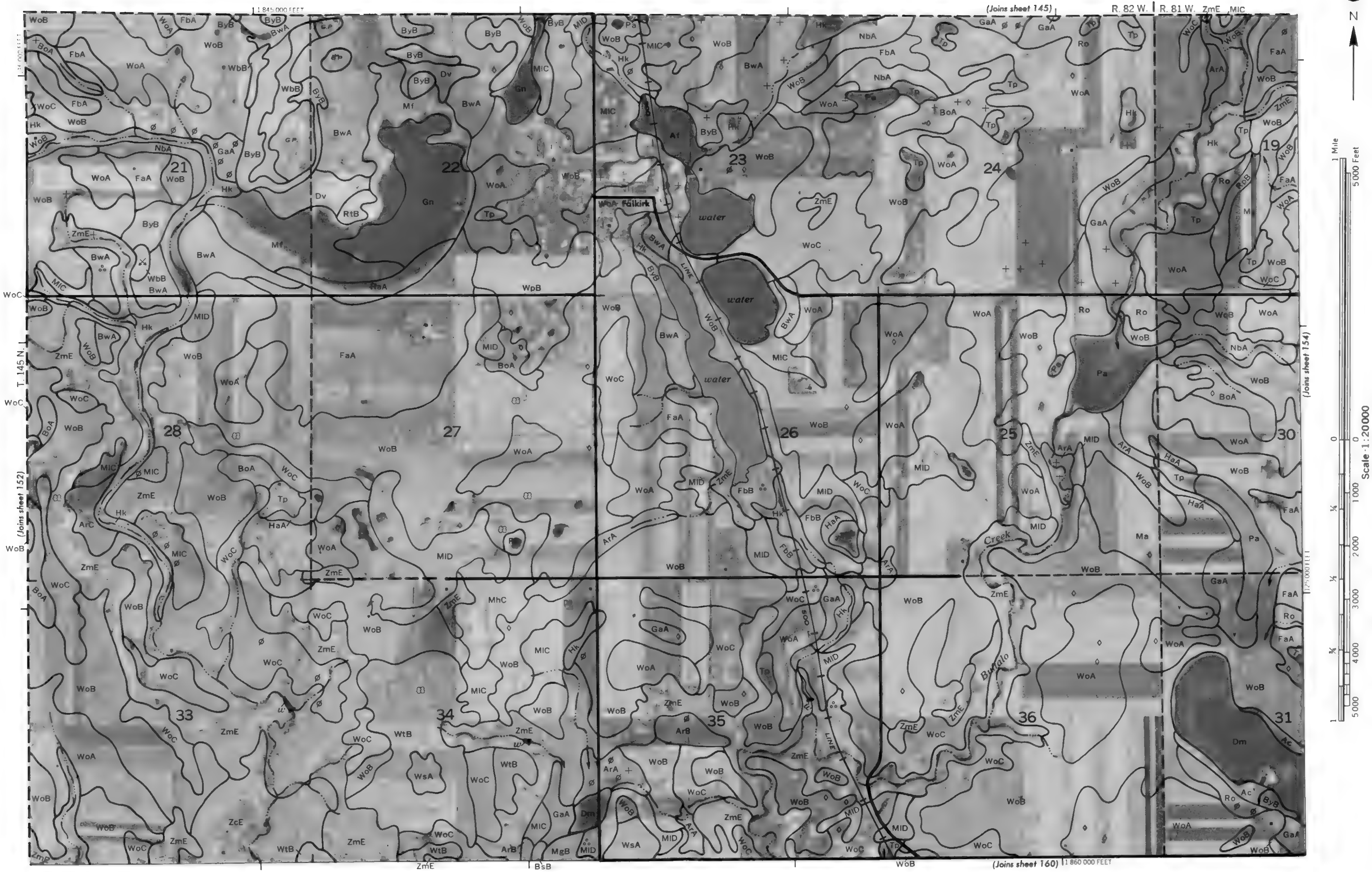

N
R. 79 W
(Joins sheet 141)
1 940 000 FEET
150 000 FEET
T. 145 N.
(Joins sheet 148)
SHERIDAN COUNTY
(Joins sheet 157)
1 955 000 FEET
140 000 FEET
1 Mile
5000 Feet
Scale 1:20000
4
3
2
1
9
10
11
12
16
15
14
13

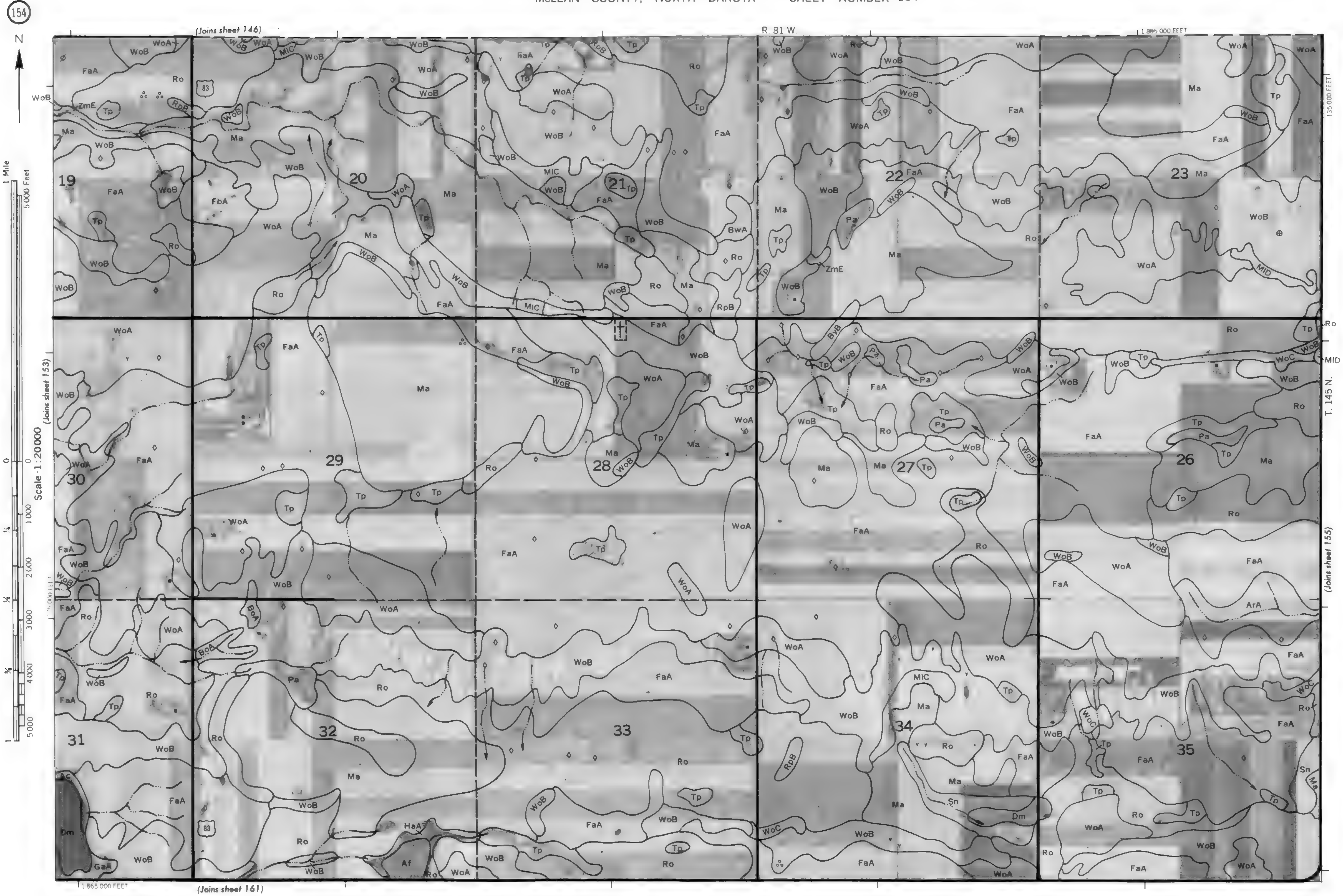

N
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
R. 84 W.
1 790 000 FEET
(Joins sheet 150)
T. 144 N.
(Joins sheet 158)
1 786 000 FEET
1 110 000 FEET
MISSOURI
MERCER COUNTY
RIVER
4
5
9
16
Hn
Ho
Tr
Bk
Lw
MdA
MdB
MdC
LmD
ZmE


R. 84 W.
(Joins sheet 142)
1 790 000 FEET
T. 145 N.
(Joins sheet 151)
1 785 000 FEET
(Joins inset, sheet 150)
MISSOURI
MERCER COUNTY
RIVER
23
26
35
Ba
Rm
MdA
MdB
MdC
PhA
PoA
PoB
LmC
LmD
ZcE
ZmE
MlD
WwC
WtB
Hn
Ho

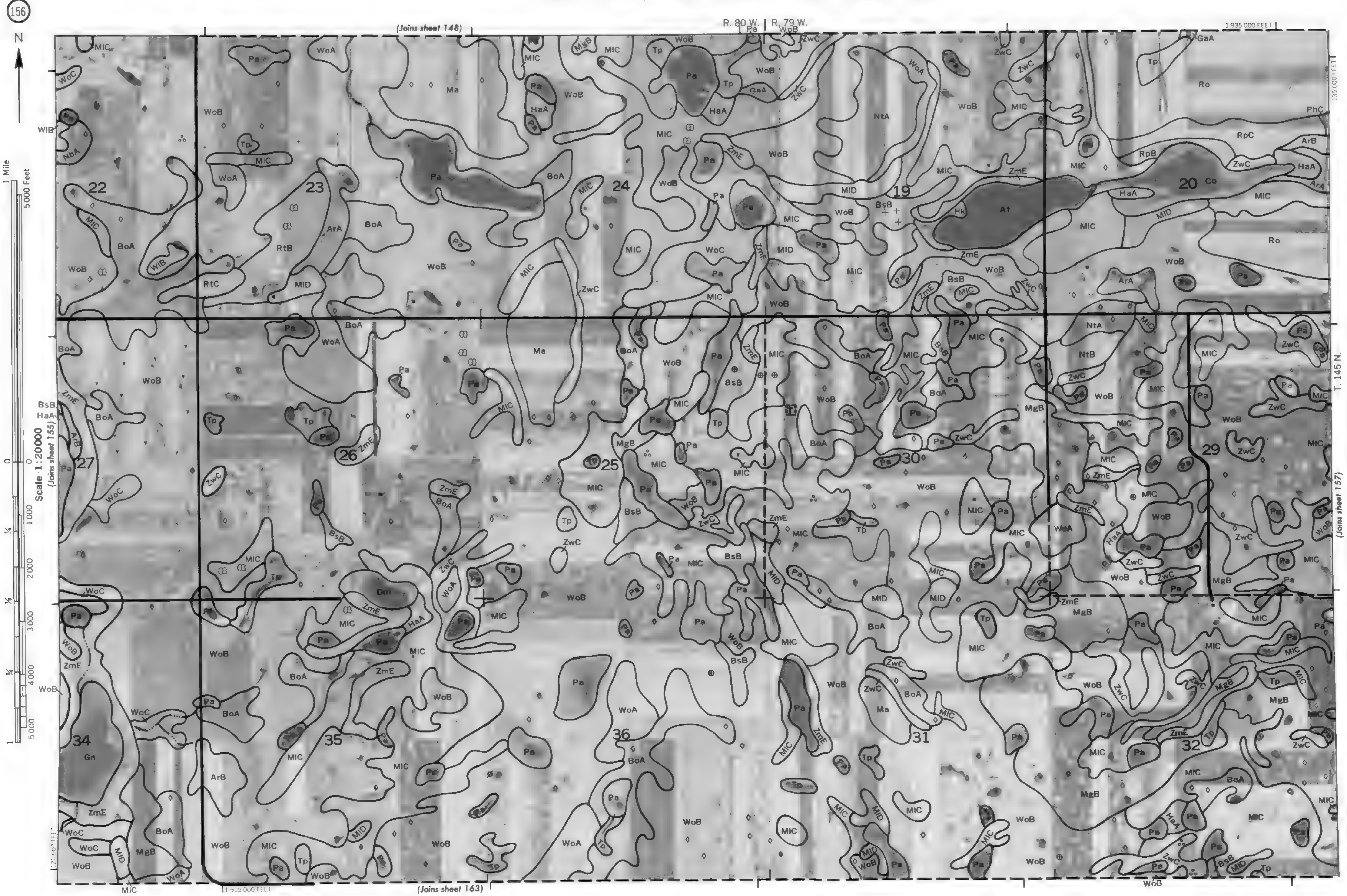

1 795 000 FEET
R. 84 W.
R. 83 W.
(Joins sheet 143)
135 000 FEET
T. 145 N.
(Joins sheet 150)
(Joins sheet 152)
125 000 FEET
(Joins sheet 158)
1 815 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36


152
N
(Joins sheet 144)
R. 83 W. | R. 82 W.
1 840 000 FEET
T. 145 N.
(Joins sheet 151)
(Joins sheet 153)
(Joins sheet 159)
1 820 000 FEET
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1
19
20
22
23
24
25
26
27
29
30
31
32
34
35
36


153
N
(Joins sheet 145)
R. 82 W.
R. 81 W.
T. 145 N.
(Joins sheet 152)
(Joins sheet 154)
(Joins sheet 160)
1 845 000 FEET
1 860 000 FEET
Falkirk
water
Buffalo
Creek
LINE
19
21
22
23
24
25
26
27
28
30
31
33
34
35
36
Scale 1:20000
1 Mile
5000 Feet

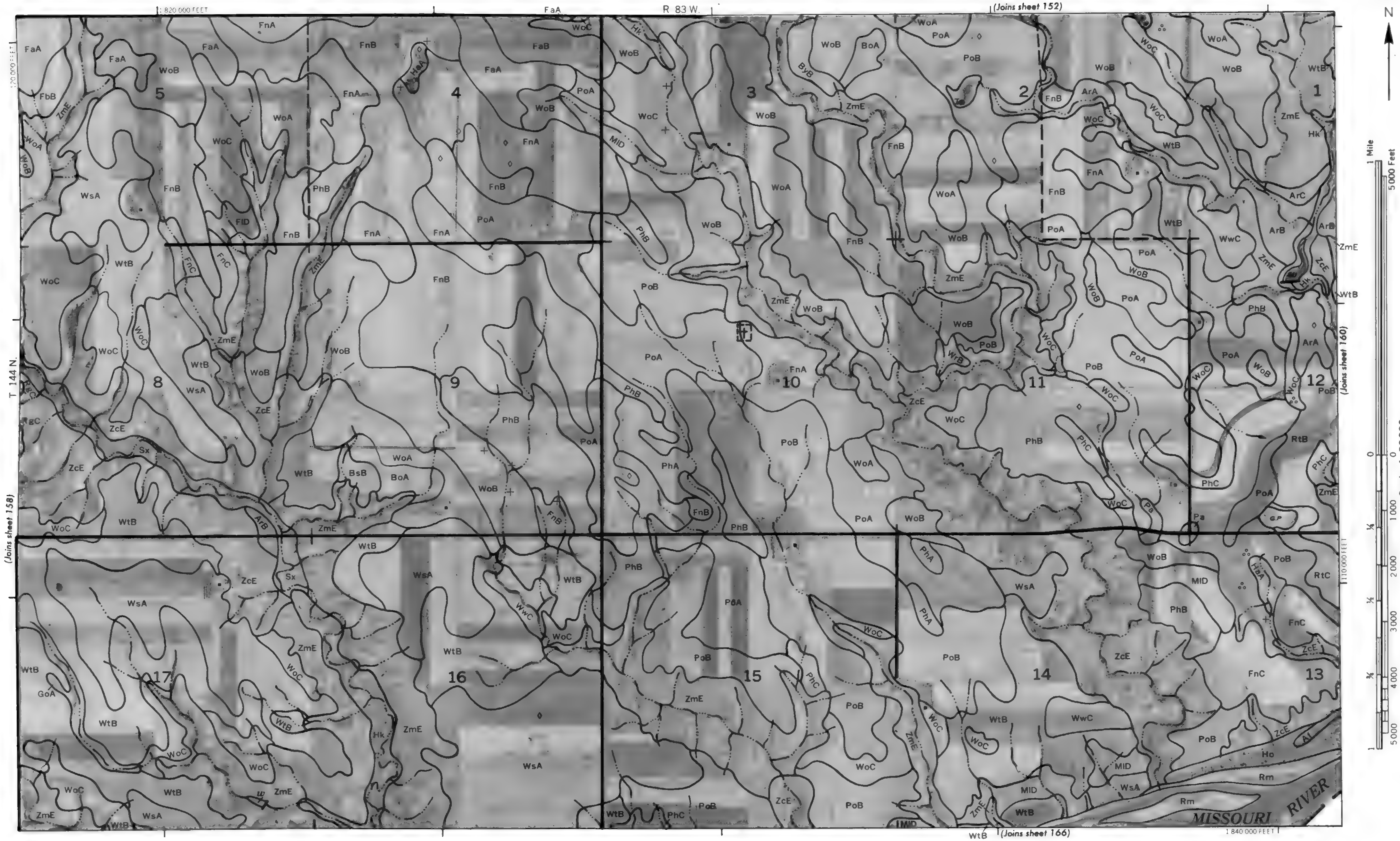

154
N
(Joins sheet 146)
R. 81 W.
1 885 000 FEET
135 000 FEET
T. 145 N.
(Joins sheet 153)
(Joins sheet 155)
(Joins sheet 161)
1 865 000 FEET
Scale 1:20000
1 Mile
5000 Feet
19
20
21
22
23
26
27
28
29
30
31
32
33
34
35

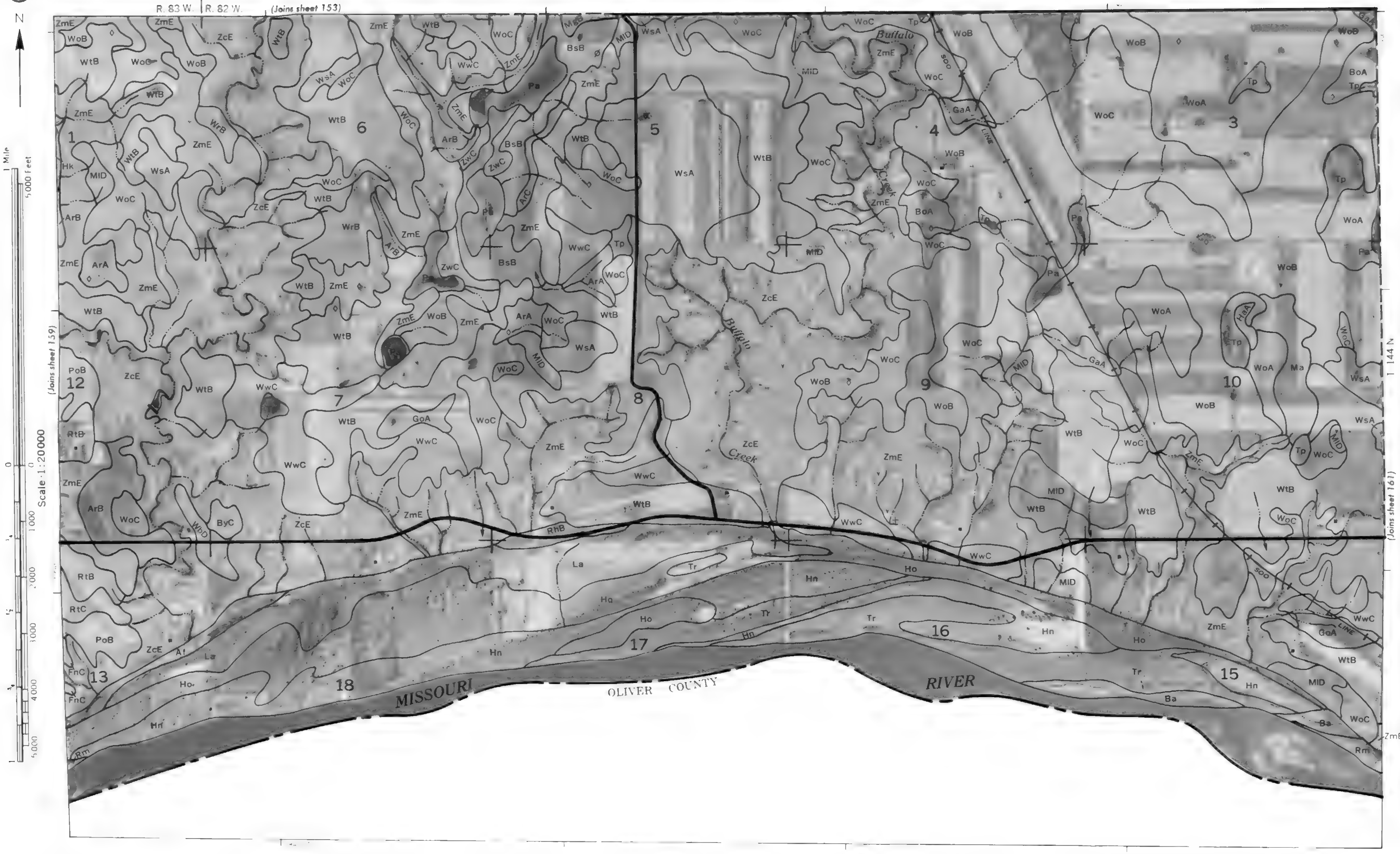

1 890 000 FEET
R. 81 W.
R. 80 W.
(Joins sheet 147)
(Joins sheet 154)
(Joins sheet 156)
(Joins sheet 162)
T. 145 N.
N
Scale 1:20000
1 Mile
5000 Feet
Turtle Creek
Intermittent
19
20
21
22
24
25
27
28
29
30
31
32
33
34
36

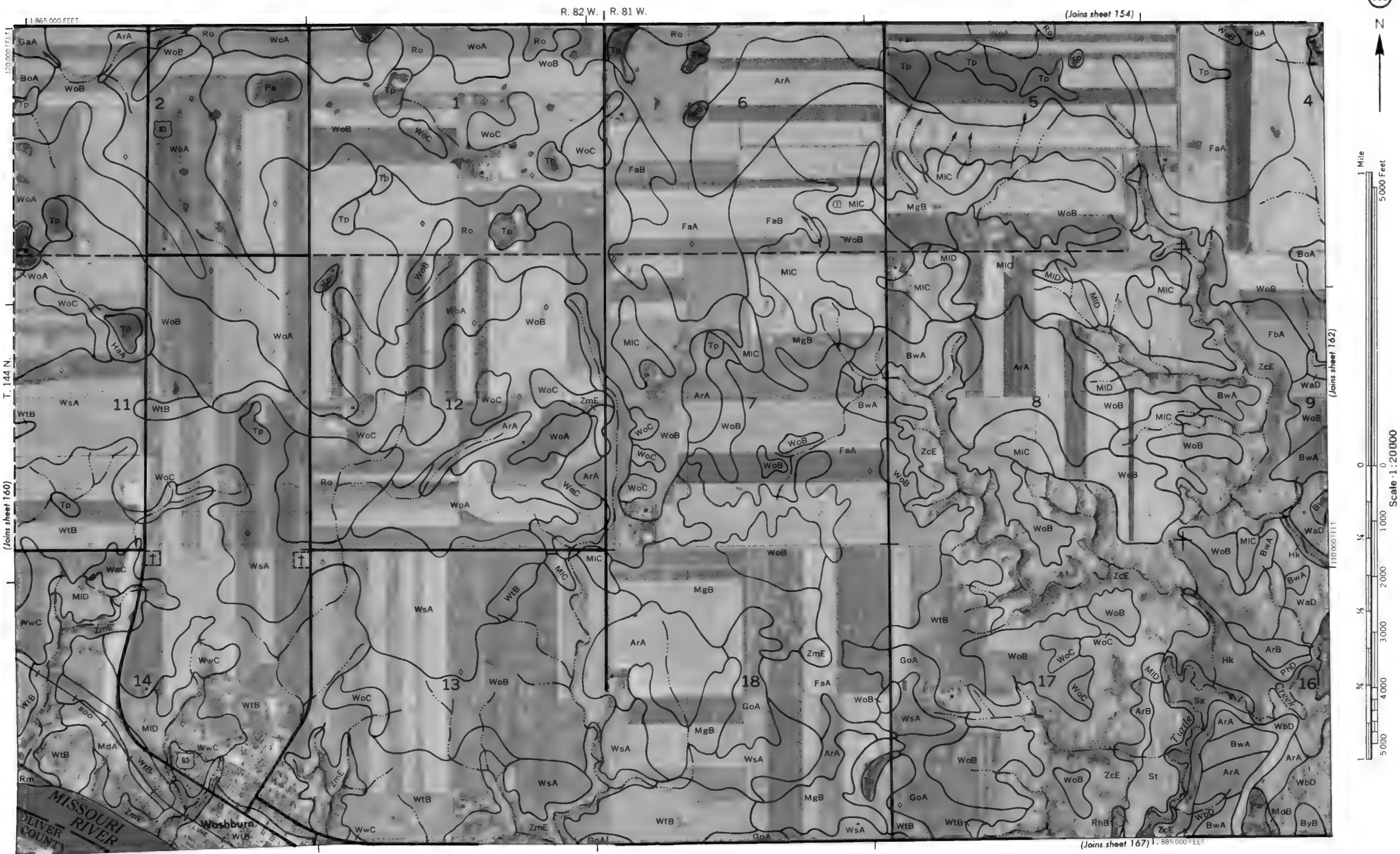

156
N
(Joins sheet 148)
R. 80 W.
R. 79 W.
1 935 000 FEET
135 000 FEET
T. 145 N.
(Joins sheet 155)
(Joins sheet 157)
(Joins sheet 163)
Scale 1:20000
1 Mile
5000 Feet
22
23
24
19
20
27
26
25
30
29
34
35
36
31
32


157
N
1 940 000 FEET
R. 79 W.
(Joins sheet 149)
135 000 FEET
T. 145 N.
(Joins sheet 156)
SHERIDAN COUNTY
(Joins sheet 164)
BURLEIGH COUNTY
1 955 000 FEET
120 000 FEET
21
22
23
24
28
27
26
25
33
34
35
36
1 Mile
5000 Feet
Scale 1:20000

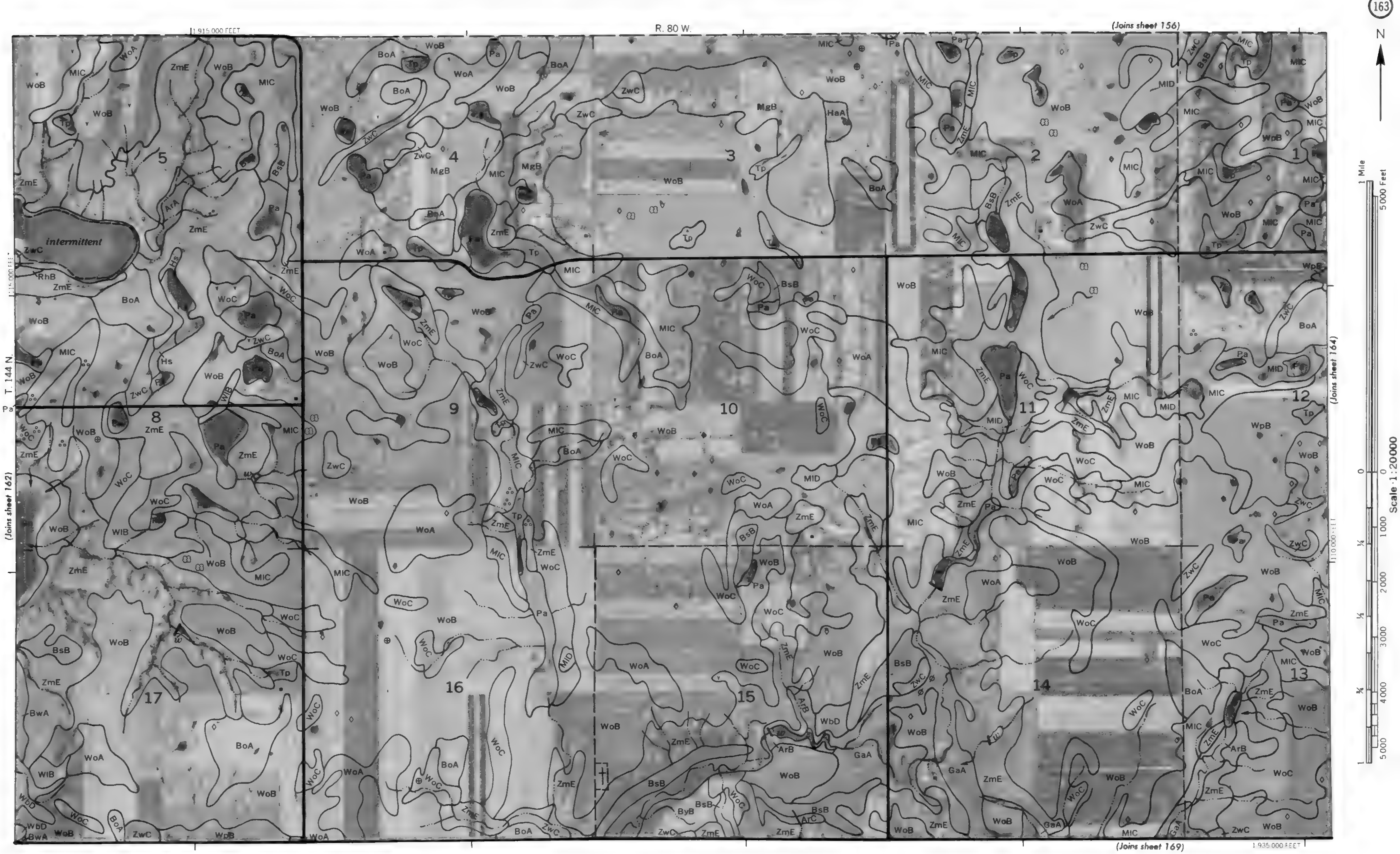

N
(Joins sheet 151)
(Joins sheet 165)
(Joins inset, sheet 150)
(Joins sheet 159)
R 84 W
R 83 W
T. 144 N.
1 815 000 FEET
1 795 000 FEET
1 Mile
5000 Feet
Scale 1:20000
MISSOURI
RIVER
MERCER
COUNTY
water
1
2
3
4
6
7
9
10
11
12
13
14
15
16
18

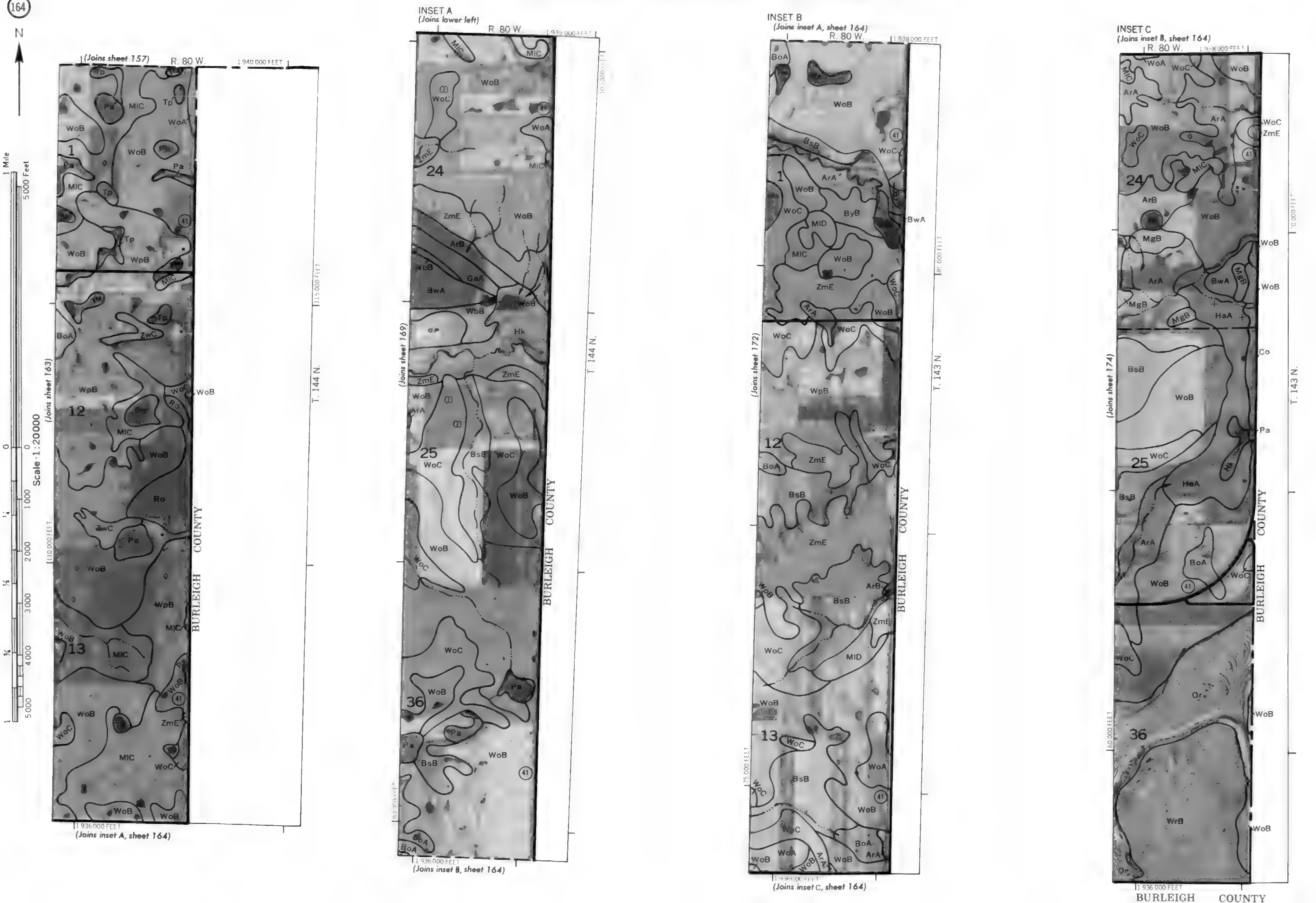

1 820 000 FEET
R 83 W.
(Joins sheet 152)
T 144 N.
(Joins sheet 158)
(Joins sheet 160)
(Joins sheet 166)
1 840 000 FEET
110 000 FEET
120 000 FEET
MISSOURI RIVER
N
1 Mile
5000 Feet
Scale 1:20000
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17

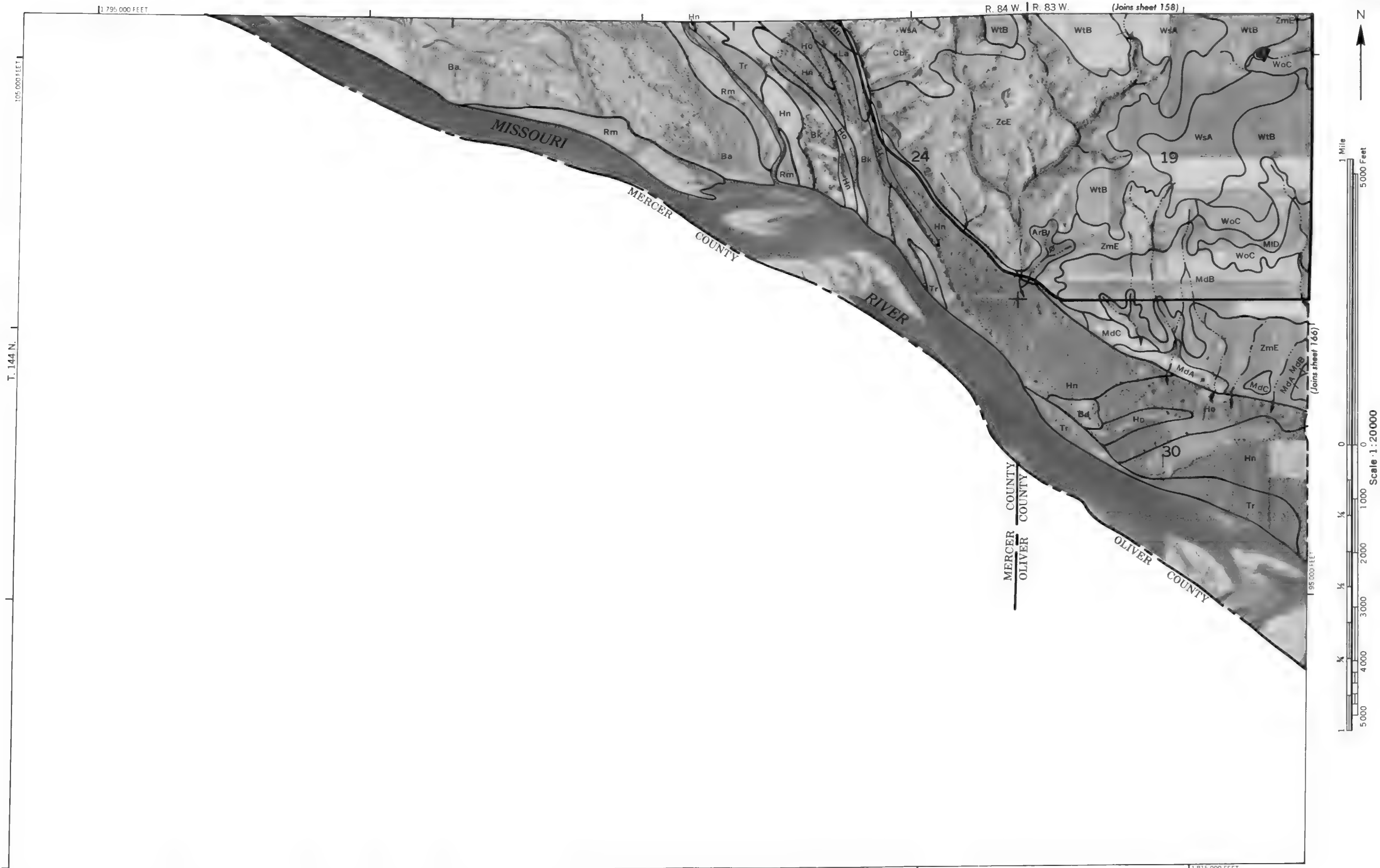

R. 83 W.
R. 82 W.
(Joins sheet 153)
(Joins sheet 159)
(Joins sheet 161)
T. 144 N.
N
1 Mile
5000 Feet
Scale 1:20000
Buffalo Creek
SOO LINE
MISSOURI RIVER
OLIVER COUNTY
1
3
4
5
6
7
8
9
10
12
13
15
16
17
18

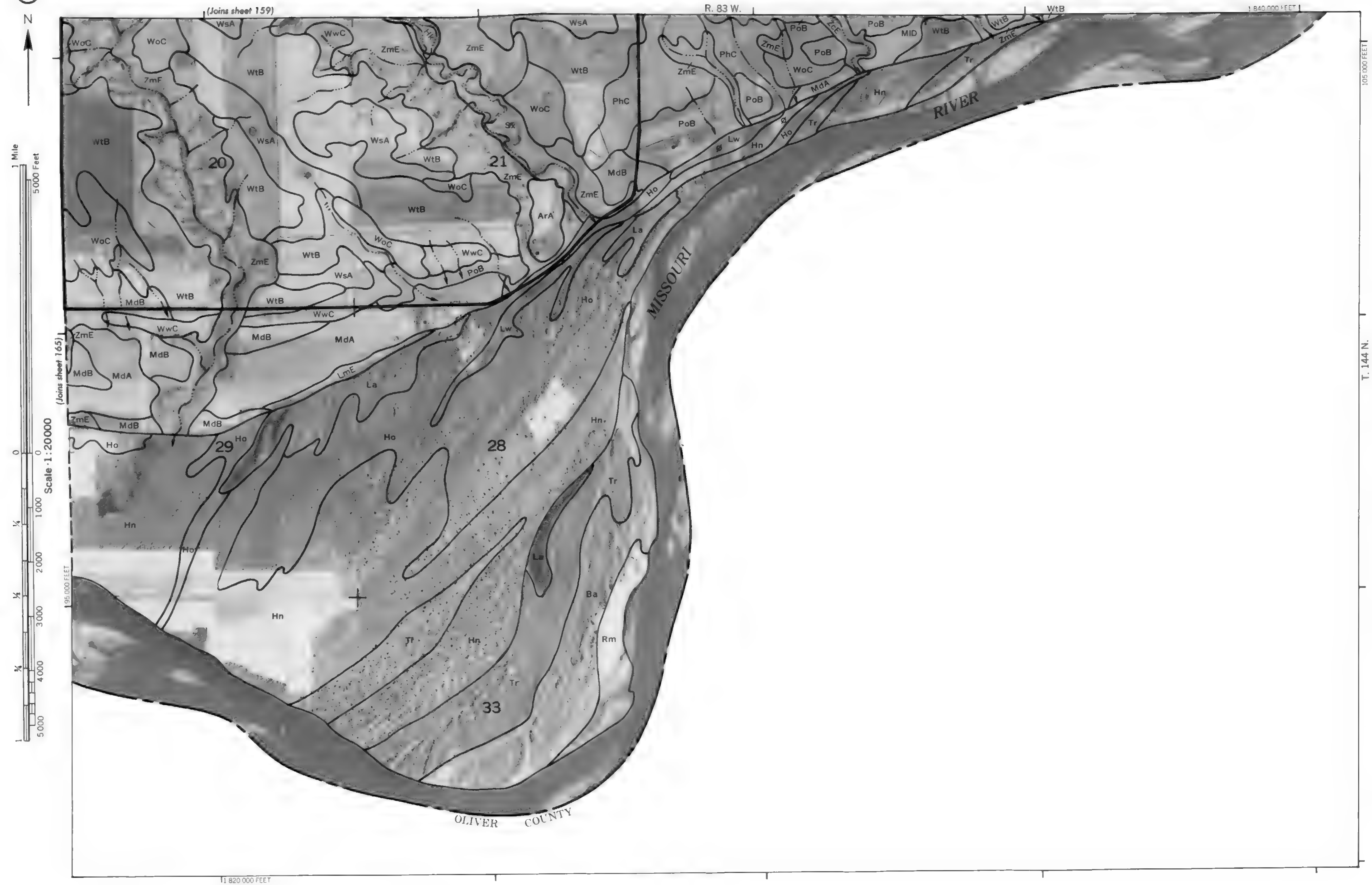

161
N
R. 82 W.
R. 81 W.
(Joins sheet 154)
(Joins sheet 162)
(Joins sheet 160)
(Joins sheet 167)
T. 144 N.
1 865 000 FEET
120 000 FEET
110 000 FEET
1 885 000 FEET
MISSOURI RIVER
OLIVER COUNTY
Washburn
SOO LINE
Turtle Creek
1
2
4
5
6
7
8
9
11
12
13
14
16
17
18
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1


162
N
(Joins sheet 155)
(Joins sheet 161)
(Joins sheet 163)
(Joins sheet 168)
R. 81 W. R. 80 W.
T. 144 N.
1 Mile
5000 Feet
Scale 1:20000
1 890 000 FEET
Turtle Creek


163
N
R. 80 W.
1 915 000 FEET
(Joins sheet 156)
(Joins sheet 162)
(Joins sheet 164)
(Joins sheet 169)
1 935 000 FEET
T. 144 N.
Intermittent
Scale 1:20000
1 Mile
5000 Feet
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17

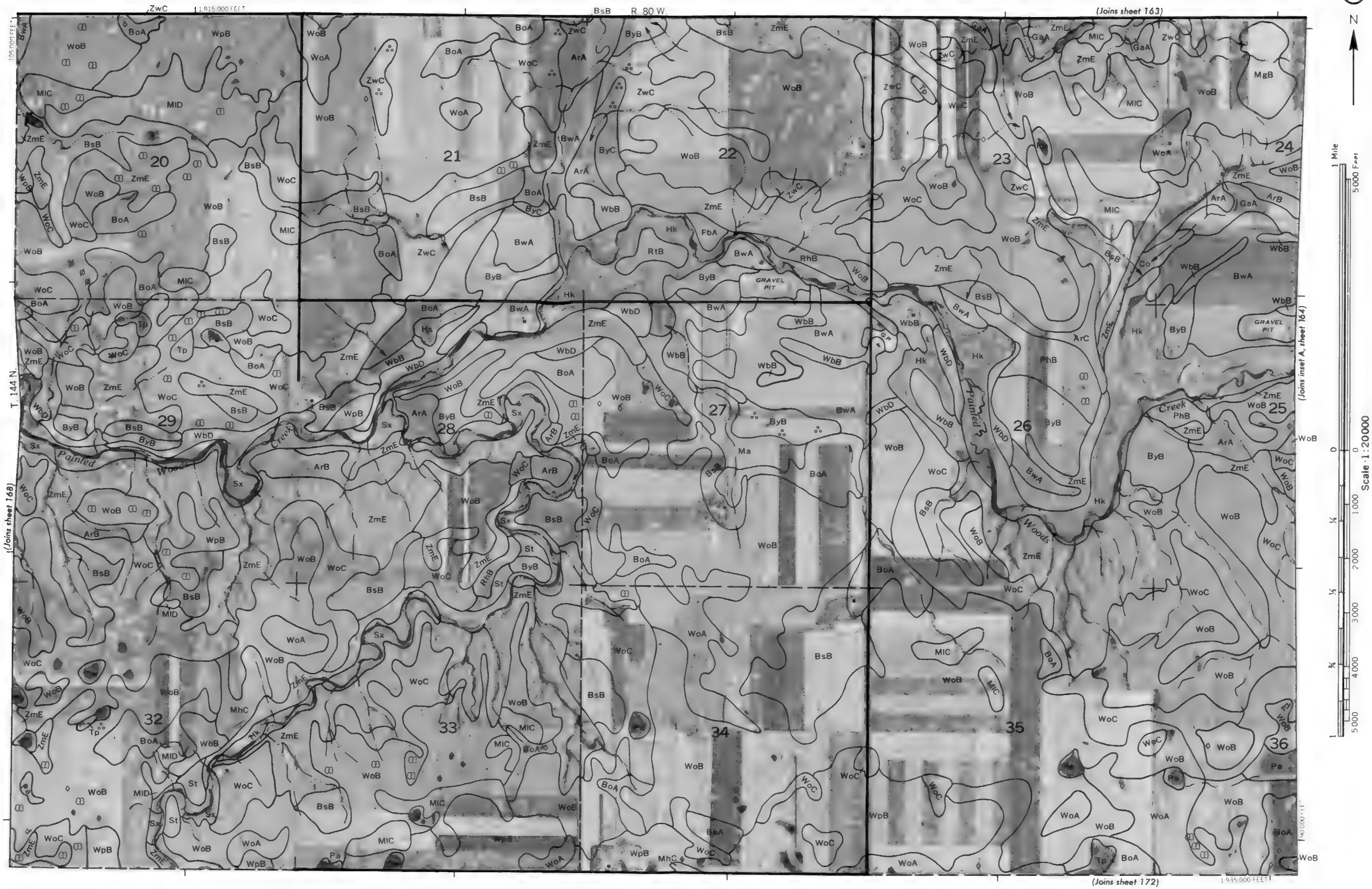

164
N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 157)
R. 80 W.
1 940 000 FEET
115 000 FEET
110 000 FEET
(Joins sheet 163)
T. 144 N.
BURLEIGH COUNTY
1 936 000 FEET
(Joins inset A, sheet 164)
INSET A
(Joins lower left)
R. 80 W.
(Joins sheet 169)
T. 144 N.
BURLEIGH COUNTY
1 936 000 FEET
(Joins inset B, sheet 164)
INSET B
(Joins inset A, sheet 164)
R. 80 W.
1 938 000 FEET
(Joins sheet 172)
T. 143 N.
BURLEIGH COUNTY
75 000 FEET
(Joins inset C, sheet 164)
INSET C
(Joins inset B, sheet 164)
R. 80 W.
(Joins sheet 174)
T. 143 N.
BURLEIGH COUNTY
60 000 FEET
1 936 000 FEET
BURLEIGH COUNTY
1
12
13
24
25
36
1
12
13
24
25
36
41
Tp
Pa
MIC
WoA
WoB
WoC
WpB
BoA
ZwC
Ro
ZmE
ArB
GaA
BwA
Hk
ArA
BsB
ByB
MID
MgB
HaA
Co
Or
WrB

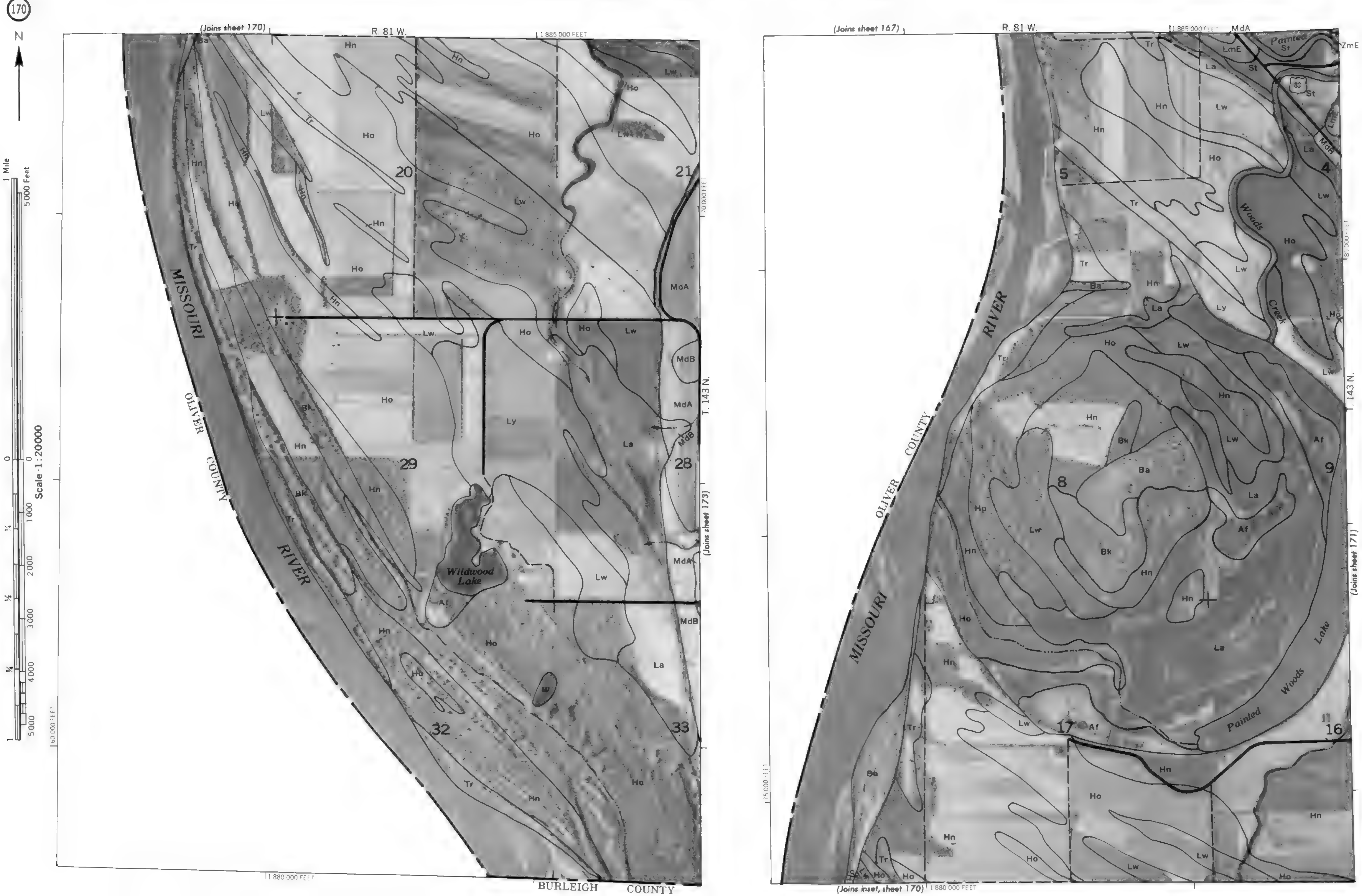

165
R. 84 W. | R. 83 W.
(Joins sheet 158)
(Joins sheet 166)
T. 144 N.
MISSOURI
RIVER
MERCER COUNTY
OLIVER COUNTY
24
19
30
Ba
Rm
Tr
Hn
Ho
La
Bk
Cbf
WsA
WtB
ZmE
WoC
ZcE
ArB
MlD
MdB
MdC
MdA
Bd
N
1 Mile
5000 Feet
Scale 1:20000
1 795 000 FEET
1 815 000 FEET
105 000 FEET
95 000 FEET


N
(Joins sheet 159)
R. 83 W.
1 840 000 FEET
105 000 FEET
T. 144 N.
(Joins sheet 165)
95 000 FEET
1 820 000 FEET
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
MISSOURI
RIVER
OLIVER COUNTY
20
21
28
29
33
WoC
WsA
WwC
ZmE
WtB
PhC
PoB
MdB
MdA
MdA
ArA
Ho
Hn
La
Lw
LmE
Tr
Ba
Rm
MlD

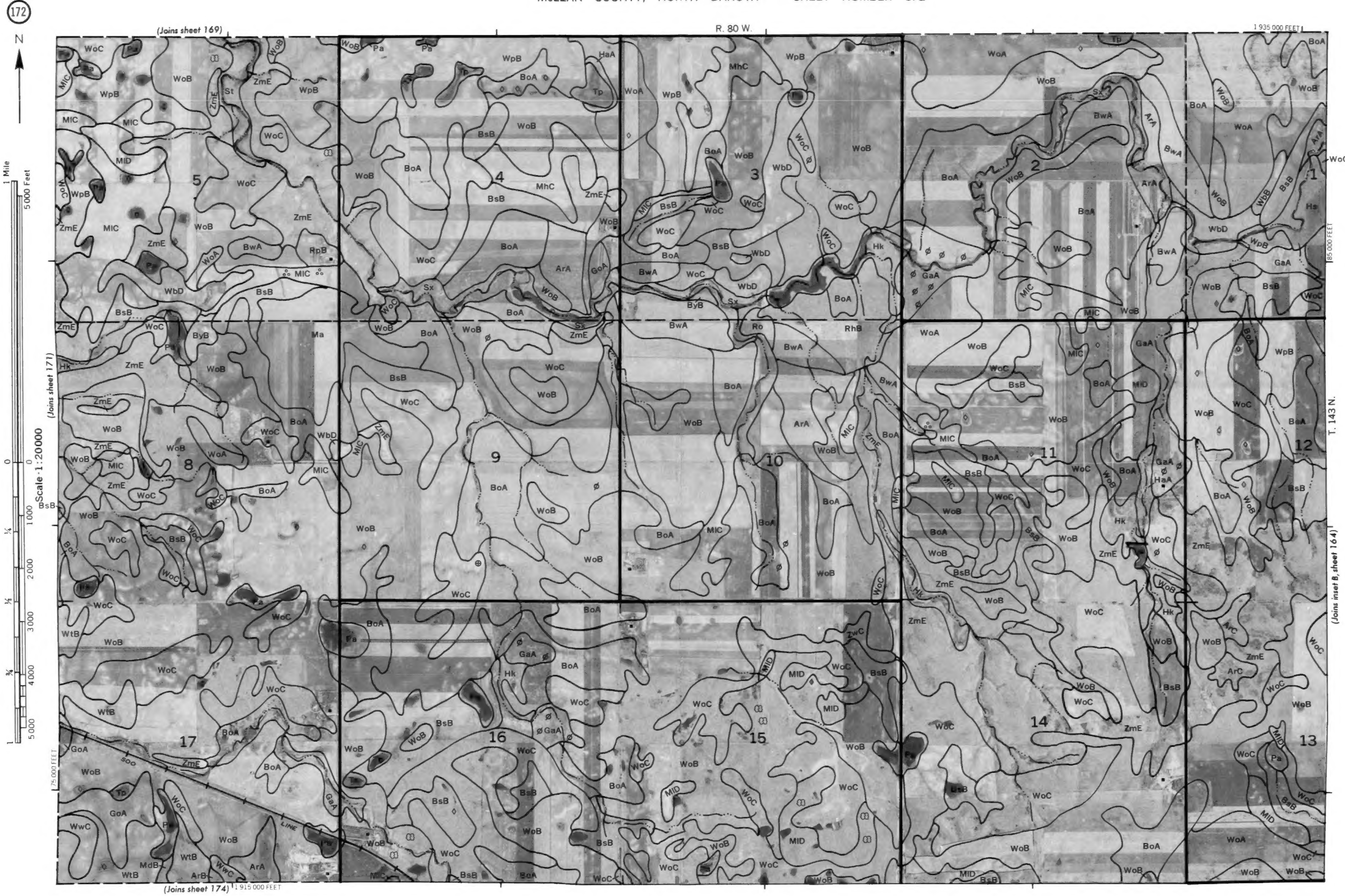

167
N
R. 82 W. | R. 81 W.
1 865 000 FEET
105 000 FEET
(Joins sheet 161)
(Joins sheet 168)
(Joins sheet 170)
885 000 FEET
90 000 FEET
T. 144 N.
Washburn
MISSOURI
RIVER
OLIVER
COUNTY
Turtle
Creek
Painted
Woods
GRAVEL PIT
SOO LINE
24
19
20
21
28
29
30
32
33
83
WtB
WsA
WwC
GoA
MlC
MlD
MdB
MdA
MdC
ZmE
ZcE
WbD
WbB
WoB
WoC
ByB
BwA
ArB
ArA
RhB
Hk
Sx
St
LmE
Dm
Tr
Pa
1 Mile
5000 Feet
Scale 1:20000
0
¼
½
¾
1
1000
2000
3000
4000
5000


168
N
(Joins sheet 162)
(Joins sheet 167)
(Joins sheet 169)
(Joins sheet 171)
R. 81 W.
R. 80 W.
T. 144 N.
1 Mile
5000 Feet
Scale 1:20000
21
22
23
24
19
28
27
26
25
30
33
34
35
36
31
water
Woods
Creek
Painted
GRAVEL PIT
LINE
SOO

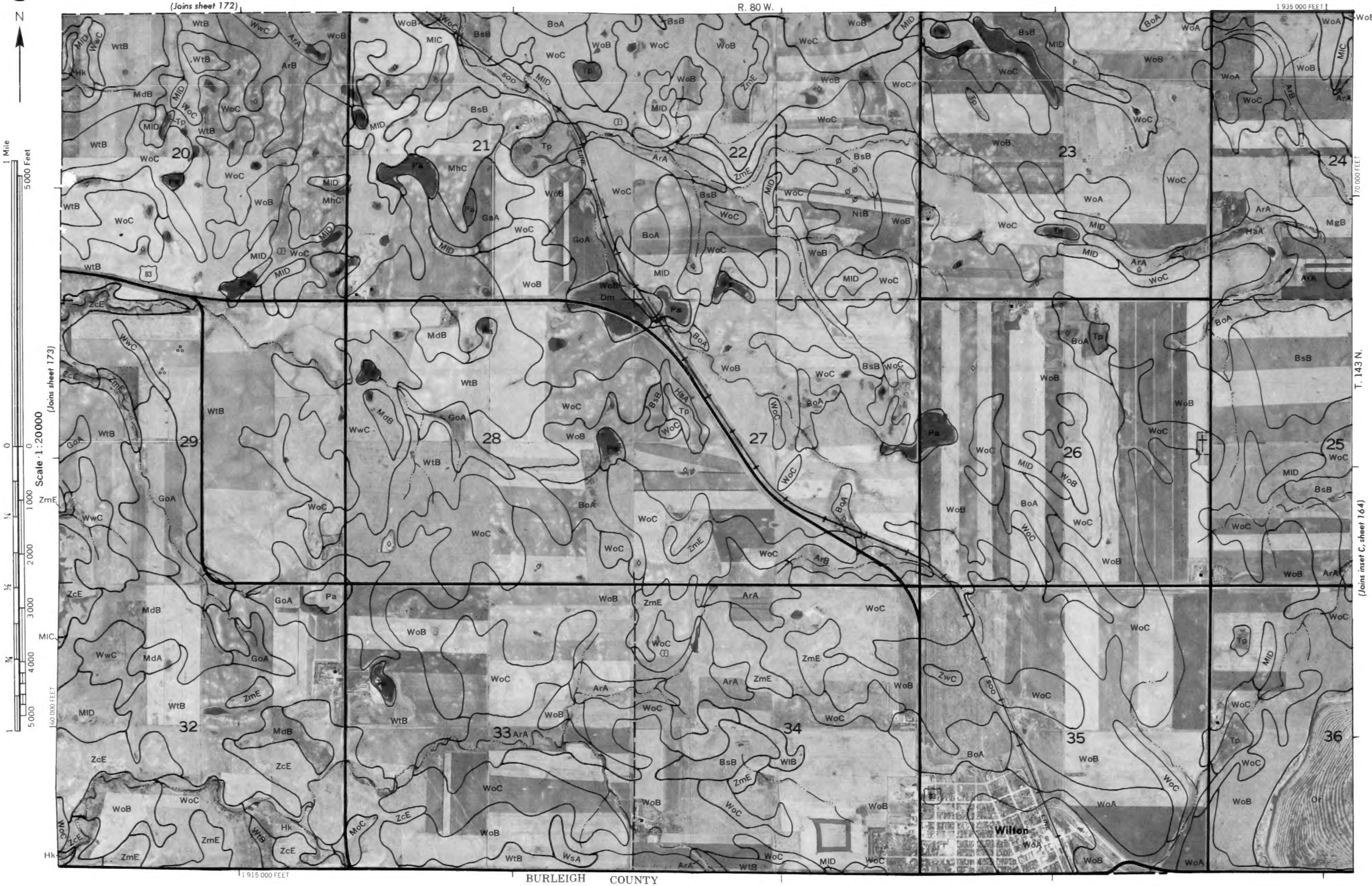

169
N
R. 80 W.
T. 144 N.
(Joins sheet 163)
(Joins sheet 172)
(Joins sheet 168)
(Joins inset A, sheet 164)
1 Mile
5000 Feet
Scale 1:20000
20
21
22
23
24
25
26
27
28
29
32
33
34
35
36
GRAVEL PIT
Painted Woods Creek


170
N
1 Mile
5000 Feet
Scale 1:20000
(Joins sheet 170)
R. 81 W.
1 885 000 FEET
MISSOURI
RIVER
OLIVER
COUNTY
Wildwood Lake
20
21
29
28
32
33
T. 143 N.
(Joins sheet 173)
BURLEIGH
COUNTY
1 880 000 FEET
(Joins sheet 167)
Painted
Woods
Creek
Painted Woods Lake
5
4
8
9
17
16
(Joins sheet 171)
(Joins inset, sheet 170)
Hn
Ho
Lw
Tr
Ba
Bk
Ly
La
Af
MdA
MdB
LmE
St
ZmE


1 890 000 FEET
R. 81 W.
R. 80 W.
(Joins sheet 168)
(Joins sheet 172)
(Joins sheet 173)
1 910 000 FEET
(Joins sheet 170)
T. 143 N.
85 000 FEET
75 000 FEET
N
1 Mile
5000 Feet
Scale 1:20000
Painted Woods Lake
water
SOO LINE


172
N
(Joins sheet 169)
R. 80 W.
1 935 000 FEET
85 000 FEET
T. 143 N.
(Joins inset B, sheet 164)
(Joins sheet 171)
(Joins sheet 174)
1 915 000 FEET
75 000 FEET
1 Mile
5 000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
SOO
LINE
1
2
3
4
5
8
9
10
11
12
13
14
15
16
17


173
N
1 890 000 FEET
R. 81 W.
R. 80 W.
(Joins sheet 171)
(Joins sheet 174)
(Joins inset, sheet 170)
T. 143 N.
170 000 FEET
60 000 FEET
1 910 000 FEET
BURLEIGH COUNTY
water
21
22
23
24
19
27
26
25
30
28
33
34
35
36
31
1 Mile
5000 Feet
Scale 1:20000
0
1000
2000
3000
4000
5000
¼
½
¾
1


N
(Joins sheet 172)
R. 80 W.
1 935 000 FEET
(Joins sheet 173)
T. 143 N.
70 000 FEET
(Joins inset C, sheet 164)
60 000 FEET
1 915 000 FEET
BURLEIGH COUNTY
Scale 1:20000
1 Mile
5000 Feet
0
1000
2000
3000
4000
5000
¼
½
¾
1
20
21
22
23
24
29
28
27
26
25
32
33
34
35
36
Wilton
SOO LINE
83